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THE PROTECTION OF SUBMARINE CABLES IN TIME OF WAR.

THE question of the protection of submarine cables in war time is of especial importance to England from her geographical position, since her sole telegraphic communication with the rest of the world depends on submarine cables, and particularly as such large tracts of ocean intervene between England and her colonies.

The international law on this subject agreed to in the Convention drawn up in Paris by the Powers a short time ago, practically leaves the question untouched, as each Power reserves to itself complete liberty of action. Let us suppose England to be at war with a strong Naval Power. Undoubtedly one of the first steps taken by the enemy would be to interrupt our telegraphic communication wherever possible.

To avoid International complications those sections of submarine cables having their extremities in English territory would certainly be first selected for interruption.

In the case of a section having one end in English territory and the other in that of a Neutral State, should this State be weak the cable would assuredly be interrupted.

In the case of a section between two Neutral States, the cable would probably be left intact though its existence might afford material assistance to England.

This condition of affairs is decidedly more disadvantageous to England than to any other Power, and especially with regard to her communications with the East, in which, with only the exceptions of Lisbon, Alexandria, Suez, and Banjoewanzie, the extremities of the submarine cables connecting England with India and Australasia are landed on British territory, and, consequently, would be completely at the mercy of a hostile Power.

For communication with China we should have to depend entirely on the overland route through Denmark, Russia and Siberia, and by way of the cables connecting Siberia with Japan and China; evidently a very undesirable route.

Our communications with the Cape are subject to the same danger, the only sections on that route which would certainly be uninterrupted are those connecting Zanzibar, Mozambique, and Delagoa, all in Portuguese territory.

From the above statements it is evident that our communications with our principal colonies, *via* the Eastern Telegraph Company's systems, are entirely at the mercy of an enemy.

We will now turn to the trans-Atlantic cables. With the exception of those starting from France and terminating at St. Pierre, Miquelon (a French possession), all the direct cables between Europe and America start from England and are landed in the Dominion of Canada. These would certainly be interrupted by an enemy. Again, were France that enemy, we on our part would certainly cut the two remaining cables, viz., those between Brest and St. Pierre.

Fortunately for the telegraphic communication between the United States and Europe there exists a route by way of Mexico, the West Coast of Central and South America, across the Andes to Buenos Ayres, along the Brazilian coast to Pernambuco and thence to St. Vincent, Madeira and Lisbon. This route would be of less use to England than to any other power in Europe on account of our insular position.

In the interest of England it is therefore evident that the only manner of securing telegraphic communications is to have at least one extremity of each cable in neutral territory.

Sir James Anderson in a recent interesting communication to the *Pall Mall Gazette*, naturally looked at the question in the interest of the company which he represents and whose success is almost entirely due to his able management. He certainly touched on a point which merits great attention, and that is, that despatch vessels belonging to the English Navy should be fitted with means of lifting cables at any points arranged, and telegraphing on their own account. We would even go further than this, and suggest that every despatch vessel should be fitted so as to be able to undertake the destruction or repair of submarine cables, and for this purpose should carry on board, besides the necessary machinery, say from forty to fifty miles of submarine cable. Enough has been said to show the weakness, so far as England is concerned, of the existing submarine telegraphic communication. It is here unnecessary to consider the fact that nearly all submarine cables are owned by British subjects.

A SHORT HISTORY OF INCANDESCENCE LAMPS.

By A. GÉLYI.

(*Continued from page* 91.)

The reader of this pamphlet will perhaps be interested to learn to what extent industrial matters were at that time tabooed by the Academy of Sciences of Brussels, and how narrow-minded and biased an opinion was entertained in scientific circles of those who tilled the field of scientific research for practical purposes. When De Changy, a short time before he obtained his patent, submitted the result of his experiments to the Academy, that body appointed a committee for the purpose of subjecting his invention to a crucial test.

Deprez, a member of that committee, requested Professor Jobard by letter to furnish a detailed description of the apparatus relating to De Changy's invention, together with a full account of the technical proceedings. M. Jobard was, of course, compelled to answer that he could not possibly comply with that request, as the publication of the information required might be

detrimental to the patent applied for. Deprez then declared, in reply, that as De Changy intended to convert his invention into a lucrative business he did not deserve to be called a *savant*, and that the Academy could not for that reason further occupy itself with his invention.

This answer was, of course, not calculated to encourage De Changy in the pursuance of his researches; and so it came to pass that he shortly afterwards abandoned his experiments with carbon glow lamps. We must now record the curious fact that the materialism of modern times appears not to have been without its demoralising influence on the so sternly scrupulous Deprez, for even he does not at present think it beneath his dignity to turn to a profitable account the results of his scientific researches.

During the next 15 years little worthy of note is recorded in the history of the glow lamp. From time to time a "newest and most perfect invention" was announced which, as a rule, ended in smoke, without leaving the least trace of its existence. It was not until the year 1873 that the development of the glow lamp entered upon a more favourable course. A Russian *savant*, M. Lodyguine, succeeded in inventing a glow lamp, for which the St. Petersburg Academy awarded him the grand prize. We summarise the principal features of his system as follows:—In an exhausted recipient he placed small needles of gas carbon, whose ends were fixed in two cubes of the same material; but as the closing of the lamp was defective and could not therefore be properly exhausted, Lodyguine satisfied himself with hermetically closing the lamp in order to prevent the renewal of the consumed oxygen. But this lamp did not, notwithstanding the improvements introduced by M. Kosloff, of St. Petersburg, prove to be of any practical use, and it shared in consequence the fate of its predecessors. The same may be said of Konn's and Bouliguine's carbon glow lamps, which were patented in 1875 and in 1876, respectively. All these lamps exhibited the same fault, namely, that the glowing carbon strips became gradually disintegrated and finally broke off in the middle, and that the renewal of the broken carbon strips was, on account of the hermetical sealing of the lamps, attended with great difficulties.

After so many fruitless attempts, a man came on the scene who was already celebrated for his successful labours in the different branches of electrotechnics; a man who, animated by a restless zeal for novel and successful inventions, imagined to reap fresh laurels in the field of glow light illumination. That man was Edison. In the year 1878 Edison was on a long journey in the Rocky Mountains, accompanied by a celebrated American natural philosopher, who awakened in him the desire to occupy himself with electric lighting.

No sooner said than done! On his return to his seat at Menlo Park, Edison completely furnished his laboratory with the apparatus necessary for the study of the electric light, and set to work at once; and from that moment he continued his labours, in spite of many disappointments, with a tenacity characteristic of him. Edison commenced by experimenting on arc light lamps, but he soon abandoned those experiments in order to follow in the beaten track of his predecessors, who tried to solve the problem of the glow lamp.

Like De Changy, Edison imagined that he would more easily and quickly succeed in constructing a metal than a carbon glow lamp, and the question was to ascertain which metal was the most suitable for that purpose. It cannot be disputed that Edison obtained better results with metals, especially with platinum, and came nearer to the construction of a platinum glow lamp fit for use than any of his predecessors. But it must, on the other hand, not be forgotten that Edison, not to mention the lessons taught by the experience of his predecessors and the incomparably better and improved apparatus which was then at his disposal, also in another respect laboured under far more favourable circumstances than most of his brother-electricians. It was, namely, the want of funds necessary for conducting their experiments that crippled most of the inventors, for the majority of those philosophers enjoyed but very moderate incomes, and it was not every one of them who succeeded in interesting a man like Peabody in his inventions. But Edison was differently situated. The Electric Light Company, which Edison had formed, placed an unlimited confidence in the genuineness of his inventive mind, and spared no expense necessary to enable him to reach the object he had in view.

We will here relate an incident which may be considered as a testimony of Edison's tenacious force of will, as well as of the colossal funds he had at his disposal; when, namely, Edison, whilst searching for a substance suitable for his glow lamp, despatched able assistants provided with ample means, in all directions of the compass. One of those gentlemen having called his attention to thorium as a metal particularly difficult to fuse, Edison addressed himself at once, by letter, to one of the most celebrated mineralogists of the United States, with the request to send him a small quantity of that exceedingly rare metal. The mineralogist answered him, with true Yankee sarcasm, that it would afford him an infinite pleasure to send the able electrician a few hundredweights of that metal, but that there was an insuperable difficulty in the way, namely, that there was not in the whole territory of the United States half-an-ounce of thorium to be found.

What did Edison do now? He sent at once for one of his most able assistants, and informed him that in one of the gold mines in the Northern States monarite crystals, from which thorium is extracted, had been found amongst a mass of worthless flints. He then gave him a letter of credit for a considerable sum, and told him—"Start at once, and bring me in the shortest possible time 100 lbs. of monarite." Within three days 20 miners were at work in the mine in question, under the direction of the young assistant, who paid his workmen liberally, and also allowed them the gold which was found during those operations, his sole object being to obtain monarite. After a few weeks the assistant returned to Menlo Park with the required 100 lbs. of monarite. Edison began his experiments on the same day, but did not fail to send the sarcastic mineralogist first a few pounds of that metal, of which he had asserted that not half-an-ounce was to be found in all America.

This interesting fact shows sufficiently with what means and on how extensive a scale the celebrated American inventor conducted his researches and experiments.

The thorium, which had been obtained in such an adventurous manner, failing to fulfil Edison's expectations, he was compelled to follow in the wake of De Changy, and use platinum as the glow material for his lamps, and he soon succeeded in constructing a platinum glow lamp, which approached perfection far more nearly than the lamps of any of his predecessors.

As soon as the news of this comparatively favourable result was brought to the knowledge of the shareholders of the Electric Light Company they set the whole machinery of American puff into motion in order to announce to the astounded world the newly constructed glow lamp as a historical event, and as the ideal of a perfect illumination.

The electric wire spread the news in all directions to the old and the new world, and the foremost technical and daily papers, the respectable and widely-read *Times* leading, hailed in articles, which could be measured by the yard, the appearance of the wonderful means of illumination. The heedless Stock Exchange speculators eagerly availed themselves of this opportunity, and, making capital out of the cry which resounded everywhere that the days of the gas illumination were numbered, screwed up the price of the electric light shares, whilst the gas shareholders were struck with a real panic.

But the joy of the electric light shareholders was of short duration, for when the glow lamp, which had been published far and wide with the greatest flourish of trumpets, came to be practically tested, it became at

once evident how the American reporters had played with the credulity of the public, for Edison's platinum lamp, although the most successful lamp of its kind which had yet been produced, was very far from realising the conditions under which it could be brought into general use, and it vanished from a scene where it had as yet scarcely made a real appearance. A Homeric laughter, which convulsed the whole European and American press, and a rapid fall of the electric shares from 100 dollars nominal value to 20 dollars, was the answer to the "brilliant fiasco" which was brought about by the undue forwardness of Stock Exchange speculators and reporters, and it cost afterwards the most strenuous exertions to repair that fault, and to re-establish the confidence of the public which had been so grossly deceived.

For many years, long before Edison occupied himself with the construction of a glow lamp, an Englishman, J. W. Swan, worked industriously at the construction of a glow lamp with the view of obtaining his object by means of carbon. We will on this occasion give an account of an interesting experiment which he made with carbon, more than twenty years ago. Swan had, namely, as he stated in a paper read at Newcastle on the 20th of October, 1880, preserved in a crucible filled with coal dust, a number of pieces of paper and of cardboard of different shapes and sizes. This crucible he sent to one of the kilns of Mr. Wallace in order to cause its contents to be heated to whiteness. He selected from the—in this manner carbonised pieces of cardboard—a long spiral, which he mounted on two small uprights of carbon, which were connected by a good conducting wire. To this carbon spiral frame he glued a small glass plate, and after having, by means of a very good air pump, formed a vacuum, which was considered very good at that time, he connected the wires with his battery and was then in anxious expectation of a brilliant result. But he was sadly disappointed, for, instead of the brilliant result he expected, the result he obtained was absolutely negative; there was not even a trace of either light or heat on his long spiral of carbonised paper. It was evident that the battery he used was too weak and the spiral too long. He therefore repeated his experiment with a short piece of carbon and a battery consisting of more cells; and, under those altered circumstances, he obtained an exceedingly interesting result.

After the air pump had done its work, Swan observed to his great delight that his carbonised paper was raised to a red heat, as soon as it was connected with the battery which consisted of 40—50 cells; and he only required now a more powerful current in order to cause the glowing carbon to emit a brilliant light; but the battery which was at his disposal was exhausted, and Swan had now to be content with the careful study of what had happened in the carbon. He soon observed that the interior of the strip was hotter than its exterior, and that it appeared, perhaps for that reason, curved on one side. This curvature increased uninterruptedly until the arc was at last curved to such an extent that its top reached the terminals. When it came into contact with the bottom of the lamp it broke asunder, and the experiment came to an end.

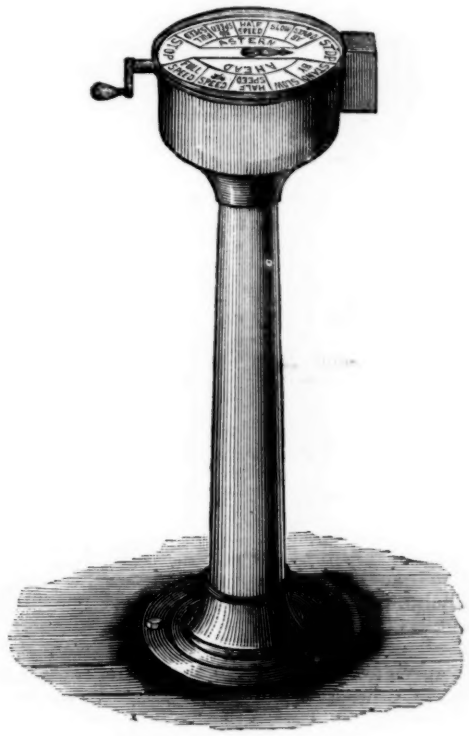
(*To be continued.*)

ELECTRICAL SHIP-TELEGRAPH.

OUR illustrations represent the transmitting and receiving instruments of Messrs. Farquharson and Lane's electrical ship-telegraph, which are of a more simple and reliable character than most of the electrical apparatus of this class hitherto designed. The instruments have been planned to overcome, by communicating electrically between the bridge and engine room, the difficulties that are experienced *especially in ships of war where the bulkheads are of great thickness*, with the present mechanical form of apparatus where toothed gearing is employed.

The transmitting instrument consists of a pointer placed over an illuminated dial, the dial being divided into the usual number of orders required; this pointer is actuated by a handle on the side of the instrument, and upon the axis of the hand is arranged a contact maker which in its revolution makes and breaks a contact at each particular order; thus, when the apparatus is in connection with a battery, a distinct signal is sent with each order.

The connection of the contact maker with the gearing of the handle is arranged in such a manner that when the handle is turned the pointer and contact maker do not move until a certain number of revolutions of the handle have been made, at which time the pointer and contact maker jump slowly to the next order. By this arrangement it is impossible for the contact maker to dwell more than a given length of time upon each successive contact, and, further, in no matter what position the handle is left, the contact maker can never, when the instrument is at rest, complete the circuit. It will be seen from this that the



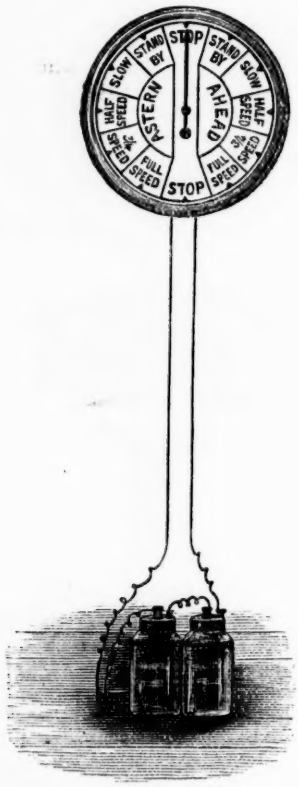
expenditure of battery power is reduced to a minimum; indeed, two or three small cells are all that are required to actuate the apparatus.

The receiving instrument, which is placed in a prominent position in the engine room, consists of a large dial divided into orders corresponding with the transmitting instrument. Upon this dial a pointer indicates the order received. This pointer is in connection with a train of clock work, the escapement of which is actuated by the currents sent by the movements of the contact maker of the transmitting instrument, each contact allowing a tooth to escape and so admitting the hand to move in a corresponding distance round the dial. At each movement of the hand a loud sounding gong, placed at the back of the receiving instrument, calls the attention of the engineer in charge of the engine room to the signal.

The whole apparatus is both simple, perfectly trustworthy and substantial in construction, and, in order to prevent the possibility of the clock work running completely down, an indicating disc shows upon the face of the receiving instrument when the instrument

requires to be wound up. In point of fact, there need be no fear of such a contingency, as the train of clock work is so arranged that once winding up before leaving harbour would certainly be sufficient to give all the orders that would be ordinarily required during a lengthened voyage.

For ships engaged upon submarine cable work we should imagine that these instruments would be of considerable value, as a set of them placed upon the bow balks and another set at the stern, would enable the officer in charge during cable repairs to have most



thorough control over the engines. We might suggest also, that if another set were used to suit the positions of the helm, the apparatus for the above-named purpose would be found of great service.

The sole manufacturers of these instruments, as also of the speed indicator of Messrs. Farquharson and Lane, an account of which appeared in our issue of December 13th, 1884, are Messrs. Latimer Clark, Muirhead & Co., Limited, of Westminster.

PROFESSOR FARMER ON ELECTRICAL LOCOMOTION.

IN the REVIEW for January 24th we published the estimates with which Prof. Farmer furnished Mr. Cyrus W. Field of the relative cost of operating the Second Avenue Elevated Railway by electricity.

Notwithstanding the high authority of Prof. Farmer, says the *American Engineer*, we must express our conviction that these estimates are entirely too favourable. The total estimated saving is based on the higher efficiency of the large stationary engines and the cheaper coal used to generate steam. The weight of coal used by the stationary engine is estimated at 35 per cent. of the amount required by the 20 locomotives, at $1\frac{3}{4}$ and 5 lbs. of coal per horse-power per hour respectively; and the coal of the central station is assumed to cost only $\frac{5}{8}$ as much as the locomotive coal. The cost of coal for the central station would then be $\frac{5}{8}$ of 35, or 22 per cent. of the present cost, a saving of 78 per cent. for the same power developed by the steam engines. This is undoubtedly too large; for while a steam engine developing 1 horse-power with $1\frac{3}{4}$ lbs. of best coal per hour is in use, yet so high an efficiency as that can hardly be expected of stationary engines in general, especially if they burn coal costing only $2·50 a ton. Further, the margin between this 78 per cent. and the percentages expressing savings in the fourth column of the table is very small. This margin must cover all losses whatsoever in transmission. It is to be noted, however, that the losses are to be estimated on the basis of loss of the cheap power of the large stationary engines and not of the comparatively dear power of the locomotives. Still it is difficult to see how Prof. Farmer has reached such conclusions. He has perhaps wisely refrained from giving us any of his processes.

One difficulty with all these rose-coloured estimates appears to be the entire failure to apprehend the difference between the intrinsic efficiency of a dynamo or a motor, and the efficiency of an arrangement consisting of a generator, connected by a conductor to a motor, for the purpose of transporting power. The intrinsic efficiency refers merely to the heat-waste in friction and in internal induced currents. If the output of the generator is measured electrically and the E.M.F. measured is the difference of potential between the two binding parts leading to the machine, then the intrinsic efficiency would cover also the power consumed in maintaining the field magnets. We very much doubt if the dynamo has yet been constructed of such superior character that 10 per cent. of the mechanical power applied to it will cover loss in friction, fugitive currents, and maintenance of field magnets. We say nothing about armature resistance, though that will be very considerable in high E.M.F. machines.

But the efficiency of a combined generator and motor for transport of power depends not only on the efficiency of these machines *per se*, but also on the counter electromotive force furnished by the motor and on the resistance of the conductors. When power is transmitted from one machine to the other at the *maximum rate*, only 50 per cent. could be recovered on the hypothesis that both machines are "perfect" electrical engines. If a higher return than this is desired, then the motor must run under a lighter load, power must be transmitted more slowly, and the current must be correspondingly diminished.

The 20 locomotives on the Second Avenue line are assumed to represent 2,200 H.P. Other reports rate each engine at 40 H.P. But keeping to Prof. Farmer's basis, this power in watts, or ampère volts, is $2{,}200 \times 746 = 1{,}641{,}200$. But as this is 90 per cent. of the power reaching the motors we have to supply 1,823,500 watts for absorption by them, or in round numbers, 1,800,000. If the 20 trains are supposed uniformly distributed over the 6·5 miles of track, and the generating station is placed at the middle, the average resistance of the middle rail is about 0·048 of an ohm. The resistance of the return rail would make a total of 0·072 ohm in the rails. This is undoubtedly too small, because of the connections that have to be made from rail to rail. The resistance might be as low as this if the track and conductor were one continuous rail. Admitting that the resistance may be made as low as 0·072 ohm, and that the loss of 10 per cent. in dynamos and motors covers maintenance of field magnets and armature heat-waste, we can readily calculate the following table for a final recovery of 1,800,000 watts corresponding to 2,171 H.P.

Current in amperes.	E.M.F. of generators.	E.M.F. of motors.	Effective E.M.F., difference.	H.P. lost in heat.	H.P. on circuit.	H.P. applied.	Per cent. of expense saved.
5,000	720	360	360	2,412	4,824	5,360	45·9
4,000	738	450	288	1,544	3,956	4,395	55·6
3,000	816	600	216	868	3,280	3,644	63·0
2,000	1,044	900	144	386	2,798	3,109	68·5

H. S. C.

This table may be verified in the following manner: Energy in watts is the product of the current in ampères and the E.M.F. in volts. The product of the current and the E.M.F. of the motor, in each case, is 1,800,000 watts or 2,412 H.P. nearly; and 90 per cent. of 2,412 is 2,171. The heat-waste may be estimated in the same way as the product of the current and the corresponding "effective E.M.F.," or as the product of the resistance and the square of the current. Thus

$$\frac{(4000 \times 288) \div 746 = 1544 \text{ H.P. or}}{(4000 \times 0{\cdot}072) \div 746 = 1544 \text{ H.P.}}$$

We may find similarly the total H.P. equivalent of the electrical energy, or we may find it by adding the heat-waste in each case to 2,412. Remembering that the electrical energy of the generator is only 90 per cent. of the power applied, we obtain this latter readily for column seven. The final column is obtained by finding the ratio between the power applied and 2,171 or the power recovered, multiplying 22 per cent. by this ratio and subtracting the product from 100. If the coal cost more or the stationary engine is less efficient, the saving will of course be less for a double reason. With a current of 5,000 ampères more power is wasted than is recovered—3,189 H.P. lost to 2,171 returned. The same is true with 4,000 ampères. But still the total cost of this power, on the basis of the assumptions made, is only 54·1 per cent. in the one case and 44·4 per cent. in the other, of what must be expended by locomotives to produce 2,171 H.P. per hour.

If the stationary engine consumes 2·5 lbs. of coal per H.P. per hour, then the estimated savings will be reduced to 23·7, 37·4, 47·9, and 55·7 per cent. respectively. It is easy to see, therefore, that the estimated saving in coal is very precarious.

We may show also incidentally that limits are set to the E.M.F. that can be used when we determine the power to be absorbed by the motor and the resistance of the line. If E and E_1 are the E.M.F. of generator and motor respectively, taken as the difference of potential between the binding posts of each machine, R the resistance, and W the power absorbed by the motor, then we have

$$E_1 C = \frac{E_1 (E - E_1)}{R} = W = \text{a constant.}$$

If W and R are both constants then $E_1 (E - E_1)$ is also a constant. When the product of two numbers is given their sum is a minimum when they are equal to each other. The sum of E_1 and $E - E_1$ is E, the E.M.F. of the generator. In the case before us E_1 equals $E - E_1$ when each is 360 volts. Hence the minimum E.M.F. of the generator or difference of potential between its binding posts is 720 volts. Similarly an upper limit is established by the ratio of the counter to the direct E.M.F. In the present problem, with a current of 2,000 ampères, the counter E.M.F. is 86·2 per cent. of the direct. That is probably higher than is now attained in practice, and would correspond, in this case, to a direct E.M.F. of 1,044 volts. The E.M.F. to be employed under the assumed conditions would lie somewhere between 720 and 1,000 volts, probably nearer the former than the latter. It is then easy to see on what doubtful grounds such estimates of savings as those of Prof. Farmer are made. The percentages of savings in the last table are lower than his, but they are still undoubtedly too high, because of the assumed high efficiency of the stationary engines, the extremely low resistance of the electric circuit, and the minimum allowance made for losses in the dynamos themselves. When, however, we add to the possible saving in full the reduced expenses referable to other items, such as dispensing with skilled labour of locomotive engineers and the smaller loss from depreciation of rolling stock, it is evident that the faith of the foremost electricians in the entire feasibility of operating elevated roads by electricity is well founded.

THE JABLOCHKOFF AND GENERAL ELECTRICITY COMPANY, LIMITED.

THE registration of this company, which was recently reported in our columns, may be said to be a sign of the times, an indication among many others of a revival of confidence as to the future prosperity of the electric light.

The causes which led to the feverish rush three years ago for shares in electric companies, the excitement judiciously fanned by interested persons, and the unscrupulous advantage taken of the opportunity by company promoters; all these, and the collapse which naturally followed, have been duly chronicled and commented upon in this journal. Many of the companies thus formed paid enormous sums of money for patents altogether untried and often utterly worthless, in a few cases only was there a business existing which by judicious management might be extended and developed. Among the latter must be classed the late Jablochkoff Electric Light Company, but here too a payment of £150,000 for patents, besides a large sum for plant, some of which was of an obsolete type, was a fatal error, sure to end in disaster. When the crash came this company, among many others, was forced into liquidation, and for some months past the business has been carried on by direction of the Court of Chancery. However, at the beginning of the new year, a few gentlemen having satisfied themselves as to the soundness of the business and the commercial value of the enterprise, subscribed amongst themselves the necessary funds, and, having purchased the undertaking, commenced business as a limited company under the title at the head of this notice.

The Jablochkoff candle is the most simple of all arc lights, the carbon points being fixed at proper distances apart, and retaining their relative positions as they are consumed. No mechanical arrangement of any kind is required in the lamp, it being only necessary to have a holder consisting of two pieces of metal connected by terminals with the electric wires; the candles are usually burned in series of five, they last about two hours, and when one is consumed a new one in the same lamp is switched on. This arrangement requires a considerable number of wires, but it has the great merit of extreme simplicity.

The candle-power of the Jablochkoff with 4 millimetre carbons is less than many other arc lights, but its 400 C.P. occupies a position between other arc lights and the incandescent lamp, and is thus more suitable than any other for many places.

For large shops the incandescent lamp is expensive, but the Jablochkoff is eminently adapted for them. Mr. Whiteley, of Westbourne Grove, who has tried several types of lamps, both arc and incandescent, and having given the Jablochkoff system a thorough trial for some years, is now fitting up all his new shops in the Queen's Road with the Jablochkoff light, which he says is, in his opinion, the simplest and most economical. This from a man of Mr. Whiteley's business experience is high praise. We have always thought well of the system, and believe that if the management of the new company will charge moderate prices and do their work well, paying careful attention to the manufacture of the candle, they should command a good business, and, if economy be practised, achieve a financial success.

The factory at the Albert Embankment is well arranged and fitted with all necessary steam machinery and tools for an extensive business. It is illuminated throughout by the electric light both arc and incandescent, the alternating Gramme machine being excellently adapted to work both systems at the same time. We are pleased still to find Mr. Reeves as the business manager and Mr. Reginald Newington at the head of the electrical department, both being competent and hard workers in their respective spheres. We heartily wish the new venture every success, feeling sure that honest and energetic management only is requisite to bring the Jablochkoff arc light again to the front.

THE NATIONAL CONFERENCE OF ELECTRICIANS, PHILADELPHIA.

(*Reported specially for the "Electrical Review."*)

(*Continued from page* 96.)

There are certain defects that have developed themselves in these batteries that have been gradually cured. The great defect in all secondary batteries is due to buckling; an effect due to the formation of peroxide upon the plate. A lead plate when it is peroxidised deforms itself, and unless some precaution is taken you will find your lead plate will buckle up into all kinds of positions, and the two plates will come into contact. This difficulty I have sought to overcome by supporting the two plates by means of a grate made of paraffined wood. This paraffined wood is sometimes tried, but the most effective material that I have found is ebonite. These ebonite grates of the proper size are very light and very thin, though quite able to prevent all buckling.

Secondary cells have not been in use long enough to enable us to determine how long they will last. I have had them in use for four months with signs of but little disintegration of the positive plate. I think that the plates will have to be renewed only about once in every two years. But I do not care whether I have to renew as often as once in every four months.

The charm of the whole thing is such, and its cost is so trifling, that I will keep it in my house, and I am quite sure that all those who have worked in the same direction in regard to this matter of electric lighting will never give it up. The electric light itself has some sort of charm about it.

Objection is often made to the cost of introducing it, but I have protested often and often against the comparison that is drawn between the cost of gas and the cost of electricity. The two things are not to be compared. When we indulge in luxuries we don't compare the cost of the luxuries with other things. If you want fine 1834 port, you don't compare its price with common ordinary claret. If you want to indulge in a fine pheasant, you don't compare it with the old cock that crowed before Peter. So when you have a delightful luxury like the electric light you don't want to compare its cost with that of gas or sperm candles, or any other mode by which life is shortened and ultimately destroyed.

Here we have something that in the out-of-the-way houses tends to lengthen life and to satisfy us, giving us something cool and delicious; and, I say, all comparisons with gas are utterly ridiculous.

It will not be long before these enterprising light companies will bring electricity to our doors, and we will all take it. When the public can get electricity at their doors and can get it without much cost, as indeed they will, they will certainly have it.

So that I look upon the days of gas as an illuminant being numbered; but gas as a generator of power is just in its infancy, The days of gas as a generator of power and heat are coming. At the same time electricity is going to supply light such as we want.

I have made careful experiments as to the efficiency of storage. Up to the present time I have not succeeded in getting more than 40 per cent. of the power put in.

It is also a point of interest to know, as probably some of you do know, that Planté himself tried a method many years ago of covering the plates with minium, but he found that in the end it was not so effective as the form of plates in the battery ~~which be adopted~~, which, though necessarily slow, result in a better form of cell.

One of Mr. Tribe's experiments seem to show that there is a greater or less formation of lead sulphate in the action of the cell. That also shows us why the electromotive force having run down, is recovered to a certain extent after a period of rest. A great many points have been cleared up that were certainly quite enigmatical before. Now, some experiments, and I think some of those that have been published by Prof. Barker, go to show that in the Planté cell as formed by Planté, by a rather slow and tedious process, there is only, to say the most, a small amount of lead sulphate produced. I take it, that the giving out of the cell is due to the formation of lead sulphate, so that if these cells are formed by the rules laid down by Planté, they will have a tolerably long life.

Just one word with regard to gas. You will remember that a year or so ago Prof. Langley showed, I think beyond any question, that the percentage of the radiant energy from any Argand gas burner, that is effective in producing illumination, is less than one per cent. It certainly is a very curious result. There is little doubt but that most of the energy goes up with the current of heat through the chimney, and that less than one per cent. of the energy from the gas burner is effective for illumination. If this is so we can well afford to recover only 40 per cent. of the energy put into the secondary cell, and use incandescent lamps by the aid of secondary cells, and still be within the economy of gas.

Mr. N. S. KEITH: In 1878, during experiments I was then carrying on in the electrolysis of lead, and in collateral experiments which relate to the chemical action of lead in various solvents and in various electrolytes, I was led to make a secondary battery, after having made one of Planté's. I made one by coating the plates with peroxide of lead by deposition from a solution of lead in which the plates were immersed. I took 240 cast pieces of lead plate, one foot square each; I divided them into 10 cells making 24 plates in each cell, 12 of which were positive and 12 negative. By using a suitable solution of lead, a sub-acetate of lead and nitrate of sodium, and by treating that with a current of electricity I produced decomposition of the solution, deposition of peroxide on the positive plate, and at the same time metallic lead was deposited upon the negative plate, in a very finely divided and crystalline state. Some hydrogen was also deposited with the lead, an equivalent to the extra oxygen that was deposited in chemical combination with the lead upon the positive plate. These plates, after pressing the metallic lead so as to cause it to cohere and adhere to the plate, were taken from this solution and immersed in sulphuric acid, and gave a very satisfactory secondary battery indeed. I am also carrying on some other experiments in the way of storage of electricity, or in the use of secondary batteries. I can hardly give particulars, except this. The idea is to preserve the integrity of the oxide plate for an indefinite length of time, say as long as may be practically worth while. So far, after some months' use, I have been able to oxidise the plate to the desired depth, say $\frac{1}{16}$ of an inch, and preserve a backing of metallic lead. Under this change, if my theory and practice be correct, I will not be obliged to replace, as in the present known storage batteries, the oxide plate.

Prof. CHARLES H. KOYLE: For the purpose of secondary batteries we can practically only use lead and carbon, the expense of the other metals being too great to allow them to be used extensively for commercial purposes. Lead will resist the electrolytic action of the current moderately well. But the oxidising action reduces the lead to an oxide in a very short time. That leaves us only carbon for the secondary battery of the future. I think there is no way of controverting that argument.

Now, as to the manufacture of the carbon plate. The capacity of the storage battery depends entirely upon the amount of lead and peroxide of lead which you can put upon these plates. They are the substances in which the chemical action takes place, and the quantity of which you can put on the plates determines the capacity of your secondary battery.

It is possible to take carbon, and to manufacture carbon plates by the ordinary method. Take ground charcoal, ground gas carbon, and mix gas tar with it, or molasses, or any hydro-carbon. Mix them pretty dense and put into a press so as to give a shape to it, then put it into a closed furnace and carbonise it so as to drive off the gas and leave the carbon free. Those plates are pretty good for ordinary primary batteries. But when you make the shape of the press such that your plate contains a lot of little holes very much as the lead does now in use, the plate is very apt to disintegrate. There is such an enormous surface exposed that the action of the current is apt to disintegrate the plate and the face will scale off.

A better way to make the plate is then to be considered.

There is a method of making these plates which is very much liked; a method in use by the United States Electric Lighting Company, in the manufacture of carbon for their incandescent lamps. That is, to take celluloid and put it through some chemical operation which deprives it of a part of its gum, thereby leaving a substance very easily carbonised.

That substance may be cut into the shape of plates desired. You can make some of these plates thick, and some thin, then carbonise them and you will always have good plates. It is not very strong, but it is a good plate. Another method which I myself have used I have found to work very well, and I shall have more to say about it in the course of a few months. At present I can only tell you the general method. I take gas tar. If you take coal tar, put it in a closed furnace to drive off the gas, you get rid of the ordinary illuminating gas and the heavier gas which is condensed as it passes through the tubes into coal tar. The constitution of the coal tar depends first upon the constitution of the coal, and secondly upon the temperature at which the gas is driven off. The constitution of the coal tar differs to an enormous extent, I am almost afraid to say how much, when the temperature is changed to a very small extent then. The coal tar is next put into a large cauldron and evaporated.

The object is to get out the lighter parts of the coal tar. Coal tar is a very composite substance. The physical qualities of coal tar vary so much according to the temperature at which the gases were originally driven off, and again according to the temperature at which evaporation is carried on, it requires months of experiments, as I have already said, before it can be determined what is needed. You have first to form a multiplication table of temperatures here and there, and make out a list of results. Then you have the same thing over again in the evaporation process. This coal tar, when it is thus taken, evaporated and brought down to a consistency requisite, which is a matter of experience, is taken and put into a box prepared for the purpose, and put into a closed oven. The tops of these vessels are covered with sand, and one thing and another in the ordinary way to prevent the entrance of air. Then the heat is turned on, and gradually this stuff begins to boil. When it has reached a certain boiling point —and that is a matter also of experience depending upon the exact state of the tar when you put it in there—you cannot take up this evaporated mass and tell what will be its quality until it has been evaporated. Then, formulating these three things, you can tell what temperature you want to use under this tar in a boiling state. I have devised a process of quite suddenly increasing the heat. This is done by means of a double oven, one oven being heated moderately and the other to quite a high degree of heat. I had means of pushing the tar through from one oven to the other. When you suddenly increase the heat the tar no longer boils, but is carbonised. Then you have the tar

suddenly carbonised. You have a very large piece of this material which is carbonised just in that boiling condition. A more beautiful sample of a porous substance can hardly be found, and when I say porous I do not mean molecular pores, I mean pores the size of small peas. You then have to make your plate. I take this substance and cut it. It is true that this carbon is pretty hard, and wears out a saw rapidly in cutting it, so I have devised another method of preparing the plates of a proper size which do not need cutting. This is a process which I developed last winter. The method of manufacturing which I have described is susceptible of considerable uniformity. The character of these plates is porous, and they are of considerable value in a secondary battery. They are as permanent in an acid as glass is in a window. I think the secondary battery of the future is to be composed of two carbon plates, made something in that way. I do not assert that that is a better way than putting mechanical holes into the carbon, but it is considerably simpler and costs less. Or, the battery of the future will consist of sulphuric acid, carbon plates, spongy lead, and oxide of lead in their little holes. Planté is, of course, the great originator of secondary batteries. From a Planté cell you can get 40 per cent., and even more, if it is properly charged. A Faure battery will return, when carefully made, 90 per cent. It does not always do it, but it will return, under certain circumstances, 90 per cent. The charging of a secondary battery must be carried on just as the ordinary work of electro-plating is carried on.

If you have two plates and you wish to coat one with metal (it may be silver or anything else), if you use too high an electromotive force you deposit this metal in large flakes upon the plate. It looks as though there had been a snow-storm, the flakes coming down of an enormous size, and the consequence is it peels off. If you do the plating slowly and regularly with a certain amount of current per unit of surface, which is accurately determined, you get a nice coat of the metal. So with the secondary battery, if you have two plates of a given size, you will want to charge each with an E.M.F. that you may get a definite electric current per unit of surface. If you have half a dozen plates you will want to increase the force half a dozen times. That is the whole secret of charging a secondary battery made in that way. Charged with care, I think there can be no doubt but that these plates will give you all you desire in a secondary battery. As to their duration, I think they will be found good for five years.

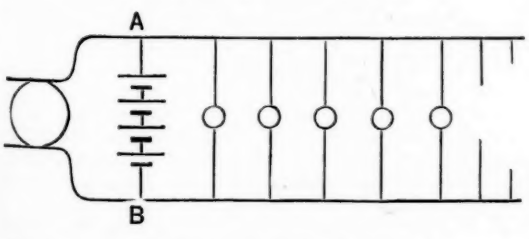
Mr. FRANK J. SPRAGUE: With regard to the 90 per cent of return, I should like to know what parts of the circuit Mr. Koyle includes. Is it including the battery, or excluding it?

Mr. KOYLE: Including the battery, of course.

Mr. SPRAGUE: I should like to call attention to the unsteadiness of the gas engine. Mr. Preece spoke of a case in which a dynamo is put in circuit with lamps, and also with a storage battery; the effect being that the dynamo may be driven as irregularly as you please, and that the storage battery has a tendency to equalise the consequent irregularity of the current.

The only reason why it will equalise the irregularity is very much the same reason as when 1, 2, 3 or 4 dynamos are running in parallel circuit. You have a light that is perfectly steady. Just the moment the motive force in this part of the circuit diminishes, then the current in the other part of the circuit diminishes. If the force fails entirely, the current in this part becomes *nil*. If it drops still further that moment one dynamo becomes a motor. If you take your current off, that moment the gas engine speeds up and sends a current back to feed the secondary battery and the lamps. With a gas engine there is considerable difficulty in starting. I am speaking of one now of about 3 or 4 horse-power. A person has to put his foot on the fly wheel and pull it round before he can get it started.

Prof. FORBES: I think it best, where we have the theory complete and have no difficulty about it, to put it accurately into proper language, and then we can see exactly what we are dealing with. The action is exactly as it has been described, and I just want to show you how the equations come out, because they are very interesting in showing the regulating action of a secondary battery upon the brightness of the lights.



Let E be the electromotive force of the dynamo; R the resistance of it; E_2 the electromotive force of the secondary battery; R_2 its resistance; R_3 we will call the resistance of the electric lamps in the circuit. That will represent the resistance of the lights which comes into play. Let us call the electromotive force of that point (A) e_1 and that point (B) e_2. These are the two points where all the three circuits unite, and e_1 and e_2 are the potentials at those points. Suppose that e_1 is greater than e_2, then the current circulating in each of these three circuits can be put down immediately in terms of the quantities which are there shown, involving the two unknown quantities, e_1 e_2. The current which is circulating in this part of the partial circuit of the dynamo from there (indicating) up to here (indicating), always takes the direction of the current as positive when the current flows from e_1 to $e_2 = \frac{e_1 - e_2 - E_1}{r_1} = c$ we may call it, r_1 being the resistance of this circuit (indicating). c_2 is obtained from c_1 by replacing E_1 and r_1 by E_2 and r_2 respectively, and similarly for c_3 (r_3 being the resistance of the lamp circuit). Finally we have the equation that the sum of all these = zero—that is to say, the total current which passes through any one point is equal to zero, which is a well-known law. We have the sum of these currents ($c_1 + c_2 + c_3$) equal to zero.

Now, in this equation, $e_1 - e_2$ is in reality the unknown quantity. It is a difference of potentials. It is the single unknown quantity of this equation. The result which we arrive at on working out this equation is that $e_1 - e_2 = \frac{E_1 r_2 + E_2 r_1}{r_1 + r_2}$. Now this is a very useful formula and probably is well known. It is an exceedingly useful one, and has important applications here. The application especially is to finding the current which flows through the lamp circuit. The current, c_3, which is the current flowing through the lamps, is equal to $\frac{E_1 r_2 + E_2 r_1}{r_3 (r_1 + r_2)}$, that is the final value of the current which is passing through the resistance of the lamp circuit.

Now, here is a remarkable thing to which attention has been drawn, and which has been commented upon by Mr. Sprague, that in this case, however much the irregularity of this dynamo machine may be, the current is found to be very steady in the lamp circuit when we use the secondary battery in that condition.

The reason of that is the secondary batteries which we are in the habit of using have an extremely small resistance, and, whenever we use secondary batteries, you will understand that we use an infinitesimally small resistance compared with the resistance of the dynamo or the resistance of any such lamp circuit.

If, then, we take the resistance of the secondary battery to be zero, our equation simply gives us, $c_3 = \frac{E_2}{r_3}$, with the other quantities cut out; that is to say, the current is exactly the same as if this dynamo was not working at all, and as if we had a battery of infinitesimal resistance, with this electromotive force of E_2 working through these series of lamp circuits.

As I am up, I may as well make a few remarks upon another point in connection with these secondary batteries. And of course the great difficulties we have had in the past times were, in the first place, that the plates buckled. This has been the most serious objection that we have had.

It is very satisfactory to hear from Mr. Preece that he found that he practically gets over the buckling of the Faure-Sellon-Volckmar battery. I do not think any ordinary separator of material which he speaks of would be sufficient to prevent the buckling of a Faure-Volckmar accumulator, for the force generated in these plates tending to buckle them is something enormous, and no ordinary separator would be able to resist this. If such resistance was offered to them I expect they would break. The reason why he has succeeded in getting rid of this buckling is because he has reverted to what is evidently the most scientific, and which will ultimately be found to be the most practicable form, that is the old Planté battery. The objection to the Faure-Sellon-Volckmar cell was not only the perfect symmetry in the plates tending to make them buckle, but also want of homogeneity in the symmetrical planes on the surface, which tended to induce local action. And that is the one great defect which has been pointed out some time ago, and which I think most people recognise now in all these batteries. In these batteries, also, the minium we used to put on would tumble off, and no satisfactory means has been devised to cause it to adhere. The larger form of Planté battery, the improved type of batteries which I believe are treated with nitric acid in order to render them more powerful, has been largely used of late, but only within the last year or two; and, therefore, their absolute life not determined. I believe it is perfectly conceded that the life of these Planté batteries, as they have been prepared with lead, and as Mr. Preece has them in his own establishment, are the longest lived batteries, far longer lived than any artificial batteries such as the Faure-Sellon-Volckmar.

(To be continued.)

Electric Lighting at Grangemouth Docks.—In a recent issue we notified the withdrawal of the electric light from the Grangemouth Docks. The Grangemouth Commissioners of Police have sent a memorial to the Caledonian Railway Company, asking that the lighting of the docks by electric lamps may be resumed, as the present gas system is found by contrast to be very inefficient. We understand the withdrawal is only temporary, and that arrangements are now being made for fitting up the electric light at Grangemouth Docks and the Central Station, Glasgow, by the company's own workmen, who will also attend to its maintenance.

REVIEWS.

J. A. Berly's Universal Electrical Directory and Advertiser, 1885. London: W. Dawson & Sons, 148–9, Upper Thames Street.

This Directory, which is now in its fourth year of publication, is almost as indispensable to the electrical profession as the huge volume of Kelly is to the general public. The improvements which are effected as each succeeding edition is issued from the press are very marked. Excision and introduction has been carried out in a very judicious manner, and while the portion devoted to British manufacturers is approaching completeness. the foreign sections are being greatly developed. Mr. Berly's enterprise has well deserved the success which it has attained.

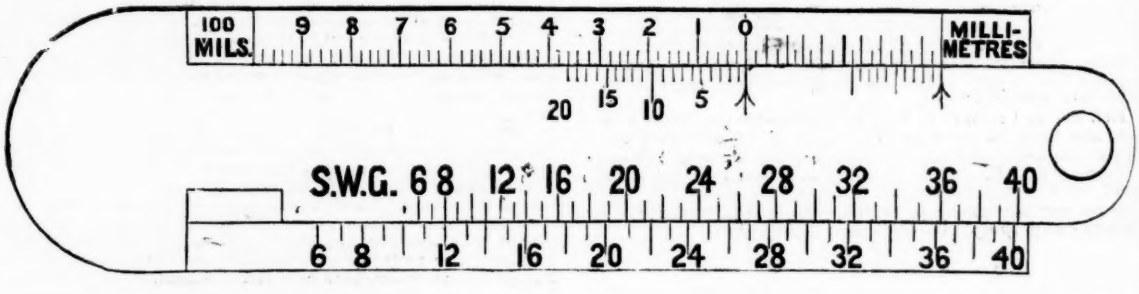
Magnetism and Electricity. By FREDERICK GUTHRIE. With Supplementary Chapter by C. VERNON BOYS. Twentieth thousand. New and revised edition. London and Glasgow: William Collins, Sons & Co.

The popularity of this book, which with all its defects is a good one, is instanced by the large sale which it has reached. The new edition is noticeable for the additional 100 pages written by Mr. C. V. Boys, which greatly adds to the completeness of the volume. The revisions which the title page states have been made, do not appear to be numerous, and the book still bears the impress of being written by a man whose practical knowledge is very small—we have only to instance the chapters on telegraphy to show this. Thus we are informed, in paragraph 329, that underground wires are sometimes covered with a sheathing of gutta percha or India rubber mixed with resin, marine glue, or silica, supported by a web of calico; we are also informed that a reflecting galvanometer is used for working submarine cables, because of the great resistance of their conductors. The illustrations of telegraphic apparatus also are not brilliant specimens of art or design. On page 110 we again have repeated the ridiculous statement that "a lightning conductor is said to protect a region around its base, whose diameter is twice the height of the point of the conductor from the ground," a statement which we have pointed out again and again was most emphatically withdrawn by the very committee which originated it. On page 225 we read, "The unit more frequently used is the Ohm or B.A. unit, which is 1·0401 times as great as the metre-millimetre mercury unit"; no note we observe is made with reference to the recently adopted value of the ohm. The supplementary chapter written by Mr. Boys deals with subjects which have sprung into notice since the first edition of the book was published; the subjects are, however, very briefly stated. The telephone and microphone are first spoken of; dynamo machines follow. In considering the theory of the Gramme machine the writer is not very clear in his explanations, though he apparently considers the action (and rightly so, in our opinion) as similar to that produced by thrusting a bar magnet into a solenoid, but this aspect of the matter is contradicted by the statement further on that the inside wire on the ring is only so much useless resistance. Electric lamps are next briefly spoken of. Then follows descriptions of secondary cells. We next have several pages dealing with units and measurement, in which a good practical description is given of the way to determine "H," viz., the horizontal intensity of the earth's magnetism. A few pages on thermo-electromotive forces conclude the book.

Electrical Units: their relation to one another, and other physical units. With a chapter on the different forms of dynamos, and a series of numerical questions. By Dr. R. WORMELL, M.A. London: Thomas Murby, 3, Ludgate Circus Buildings, E.C.

This pamphlet, which contains 48 pages, consists of two parts, which have very little connection with each other, and which, strictly speaking, ought either to have been printed separately, or ought to have had a more appropriate title than "Electrical Units." The author adds little, if anything, to previous information written on the subject; in fact, like many others, he has practically only given the matter in a form which is different to that adopted by his predecessors, and he has had it published by a different publisher. The way in which the market is becoming loaded with such works is becoming extremely ridiculous.

We do not at all mean to say that Dr. Wormell's latest production is not well written; it certainly has its good points, but we cannot say that it "supplies a want."



A NEW WIRE GAUGE.

A NEW wire gauge has just been brought out and patented by the well-known firm of Walter T. Glover and Co., of Manchester. It is the invention of Mr. A. P. Trotter.

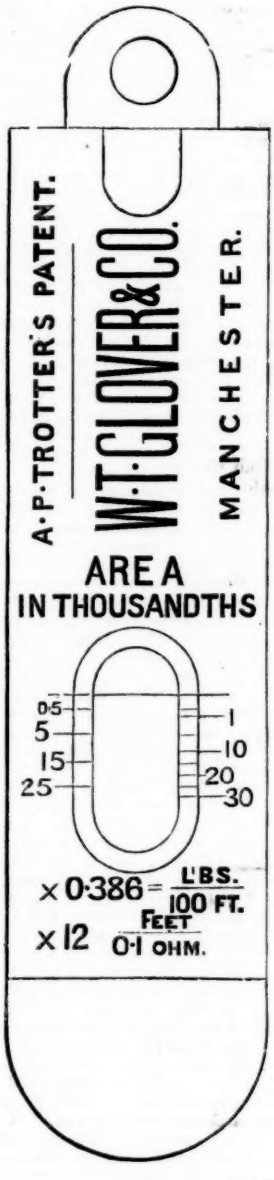
As the directions and illustrations which follow will fully explain its uses and method of operation, we need only say that it appears to us to be a very useful instrument, and that both the inventor and the introducers of the rule have done real service in thus saving the practical man a considerable amount of valuable time, which must otherwise have been taken up in lengthy calculations. Indeed, the gauge will be found, we think, to be the best yet introduced, as it gives five measurements at one operation, each of which is unerring in its accuracy.

The gauge comprises four separate scales, three of them being verniers. The long scale marked S.W.G. gives the diameter in the new Board of Trade *standard wire gauge*. This differs but very slightly from the old Birmingham wire gauge; for instance, No. 12 B.W.G. has a diameter of 0·109 in., and in the S.W.G. it has a diameter of 0·104 in.

The instrument is milled on the edges for convenience in holding, and may be opened by pushing the eye at the end of the slide. The wire or other article to be measured is placed between the jaws and nipped tight, the reading being taken on the scales.

The S.W.G. (standard wire guage) vernier is a peculiar one, and is read by observing the numbers of

the graduations which *coincide*, the two numbers being identical. For instance, if a well worn penny be nipped between the jaws it will be found that the graduation between 16 and 20, that is 18, will be opposite the *corresponding* graduation; the thickness is therefore 18 S.W.G. A new penny will in the same way measure about 16 S.W.G., and with a slightly worn penny neither 16 nor 18 will coincide, but it will be found that the half length graduation corresponding to 17 on the slide, will be in more or less accurate



correspondence with its fellow on the body, and the reading will be 16½, 17, or 17½, as the case may be. But when 18 is opposite 18, it will be noticed that the graduation 12 on the lower scale is opposite the graduation corresponding to 10 on the upper or movable scale, but these numbers not being identical the coincidence of these lines must be neglected:—*e.g.*, if a No. 8 S.W.G. wire be nipped it will be seen that the inch scale reads 0·160, the millimetre scale a shade over 4 (the exact size being 4·064), whilst the scale of areas registers 20 (·020), this giving at the same time the current in ampères (20) that the wire will safely carry. The area multiplied by ·4 gives 8 lbs. per 100 feet, and so on throughout the other calculations as to resistance, H.P., &c. Again No. 14 S.W.G. reads as 0·080 on inch scale, 2 $^{m}_{m}$ on the millimetre scale, and 5 (·005) on the scale of areas giving 5 ampères as the *safe* current for this wire. Other examples could be given, but these will serve to show the use and value of the gauge as against present methods of computation, as all the measurements made by it can be relied upon for absolute correctness; and although the scale of currents (1,000 *ampères to the square inch*) may not accord with particular theories, yet for all *practical* purposes this will be found sufficiently accurate.

The two other verniers are graduated in decimals of an inch, by which the reading may be taken in "mils" (or thousandths of an inch), or in decimals of a millimetre.

The verniers for accurate measurements should be read by lens. Each has two scales, one with an arrow head and one without. The latter is the scale proper, the former is the vernier. The arrow head points to the graduation on the scale from which the approximate reading is taken.

The first decimal figure is read on the scale by the direct indication of the arrow head. It will be found that *one of the graduations* of the vernier coincides with one of the graduations of the scale, and the following figures of the reading are the numbers which correspond to this graduation, the numbers counting from the arrow head.

On the back of the gauge is a scale by which the areas of circles, whose diameters are nipped between the jaws, may be approximately measured in thousandths of a square inch. From this scale may be computed the capacity of high conductivity copper wire for carrying an electric current by any of the well-known formulæ; but it is found that at all events up to No. 6 S.W.G., which is the largest diameter that the gauge will take, 1,000 ampères to the square inch is generally satisfactory, from considerations both of economy and resistance. The scale of areas may then generally be taken as a scale of ampères. The carrying capacity of the copper wire on an armature or magnet may be found at once by multiplying the coefficient applicable to the particular case.

The area in the following is to be taken as in thousandths, as read on gauge, not in square inches.

If the area be multiplied by 12·33, the result is the length in feet of pure copper wire having a resistance of one tenth of an ohm ($\frac{\text{Ft.}}{0{\cdot}1\text{ ohm}}$). For practical purposes the multiplier may with greater accuracy and facility be 12*. If the area be multiplied by 0·4 (more accurately 0·386), the result is the weight in pounds of a length of 100 feet ($\frac{\text{Lbs.}}{100\text{ ft.}}$).

The area multiplied by 0·323 equals Sir William Thomson's *very safe* rule of 0·5 ampères to the square millimetre.

The area multiplied by 0·0575 gives the horse-power lost per mile, with 1,000 ampères per square inch. 42·8 divided by the area gives the resistance in ohms per mile.

We feel assured that electricians generally will not be slow to recognise the ingenuity and skill of the inventor in providing so useful and practical an instrument for facilitating rapid calculations.

We understand that the above gauge may be had by applying to Messrs. W. T. Glover and Co.

The Bell Patents in Canada.—A dispatch of January 15th, from Ottawa, says:—The Minister of Agriculture has not yet arrived at a decision as to whether the Bell Telephone Company has invalidated its patent in Canada by infraction of the patent laws, as shown by evidence taken before him several weeks since. After reading over the evidence, the Minister handed it over to Dr. Tache, his deputy, an expert in patent laws, and, until the latter has carefully gone over it, no decision will be reached. The general impression, however, is, that the Bell patent will be declared void.

* The conductivity of W. T. Glover & Co.'s wire being claimed as of 98 per cent., the more accurate multiplier would be 12·08.

THE DISTRIBUTION OF ELECTRICITY.*

WHEN first I was asked to give this course of lectures on "The Distribution of Electricity" I thought it would be an interesting thing, just in a general and somewhat popular manner, to give a description of the different schemes which have been proposed for lighting large installations and central station lighting, and to simply treat what had already been written in a general sort of manner. But as soon as I began to go into the question at all I felt it would be losing an opportunity for doing something which would really be far more useful, and that was to take up the subject from a more technical point of view than that which I had originally thought of, and to discuss somewhat fully these different systems, and explain the defects of each and what were the relative merits of them, and really to go into the question in a more thorough manner than anyone has found it worth his while up to the present time to attack these problems in.

This then is the scheme which I have had before me in the course of these lectures. You all know the different systems which have been proposed for lighting. You know how arc lights have been distributed in series, and how incandescent lamps have been put on multiple arc in large stations. More especially you are acquainted with what has been done in America in this matter. In some cases only a special system has been thoroughly worked out, and in very few cases, I fancy, have different systems been relatively compared and pursued so as to bring out the most economical condition possible.

Besides these different systems I have spoken of—the series and multiple arc systems—you are aware that the latter, the multiple arc, is subdivided into a number of different ways of distributing. You have all heard people talking about the network system, the system with three mains, and also of lines of centres distribution. There are different modes of multiple arc system. And so also we have another one, which is called the multiple series system, which has been used to a certain extent, and very successfully used, but which has very radical defects in it, which have prevented its general adoption; at the same time, many distinguished engineers believe that in the future there may be a possibility of making this system efficacious and of removing the defects which are in the way. The objection to the ordinary multiple system, where all the lamps are connected to two massive mains, or to a number of wires which are so connected together as to make two massive mains, is the enormous cost of the conductors.

Besides the difficulty that the Electric Lighting Act is simply unworkable, as every unprejudiced person must admit that it is, there is no doubt another fact which has largely hindered electric lighting, and that is the enormous cost of the mains. And not only that, but the multiple arc system introduces another serious expense. It becomes essential with such large mains to have our central station and our engines in the centre of the district which is being supplied. Now, in a thickly-populated neighbourhood, such as it would be economical to light on the multiple arc system, it is very difficult to get a site for your engine and dynamos, and this has been acknowledged by those who have tried to undertake the system in London, to be one of the most serious objections to the multiple arc system. Thus at every point we see that it is of the utmost importance that engineers should devote their attention to economy in the construction of their mains to enable us to have a good supply after the most economical system of mains which is possible, whether that system be multiple arc or multiple series, or any other of the modifications which have been proposed.

The question of the production of electricity is one about which I need say very few words indeed. At the present time we produce our electricity by means of dynamo machines, by far the cheapest we have, and there is no immediate prospect of any other system being introduced which is more economical. Secondary batteries, being supplied with their power from dynamos, may be looked upon more as a system of supply than as a means of production of electricity; and the same may be said of secondary generators, which have attracted considerable attention in the last year or two. Now let us come to the problem before us, of the supply and distribution of electricity; and before taking the problem directly, let us take a general survey and a comparison between electricity and gas in this respect. The production of gas is a far more complicated operation than the production of electricity; it is a somewhat complicated chemical laboratory experiment produced on a large manufacturing industrial scale. When we come to the supply of gas the problems resemble each other at first sight a good deal. The gas must be supplied in the pipes at a certain pressure, the size of the pipes must be regulated by the supply, the pressure must be maintained, the quantity flowing must be so regulated that it shall not vary to any great amount. In all these points we have an analogue in the case of electricity. I shall use the term "pressure" in these lectures because it is now introduced as a Parliamentary term, and I do not see that it is not a correct scientific term to indicate the pressure at any point by indicating the difference of potential between the conductors at that point. We have to do the same thing with electricity as with gas; we must supply it in such a way that the pressure of electricity at different points shall not vary much. There are two points in which gas differs very materially from electricity. The one is that if you take a hundred wires of certain diameter and pass a current of electricity through them, and then pass a current through the same mass of copper grouped in one wire, the resistance offered in the two conductors is the same. If, however, in the case of gas, you pass the gas through a hundred small pipes and then through one large pipe of the same area, you have far more resistance in the hundred pipes than you have in the one. This is the reason why although we often see electrical cables made up in strands, in gas we see them in large pipes as required for the regular flow of gas. The other point of difference is in the cost of mains. The difference consists in this that with gas the pipes are hollow and it is simply the space which is filled with the illuminating material, gas, while in electricity the conductor is solid and the electricity passes through the solid material. The consequence of this is that whereas in gas the cost of mains is not in proportion to the quantity of gas which is to flow through those mains, in electricity it is certainly fully in proportion to the quantity, and that is why when we come to large electric mains we have such an expensive system to deal with.

While I am comparing with gas, allow me to say just one word about the introduction of electricity. It astonishes one to think for a moment how serious have been the difficulties in introducing electricity when really the obstacles to introducing gas were so much greater. When gas was introduced people knew nothing about a central supply of an illuminating agent, and knew nothing of the requisite size of pipes. It was a leap in the dark. The gases were objectionable, the burners infamous, smoke and sulphurous fumes were given off, and from the naked flame there was a constant danger of setting fire to houses; the gas vitiating the air, blackening surrounding objects, and the smell objectionable. Moreover it was impossible to prevent leaks, and leaks meant explosions. It was impossible to prevent ignorant people from blowing out gas or leaving cocks turned on, and in that way explosions and deaths from suffocation resulted. Electricity has none of these disadvantages. There has been great talk about risk from fire and risk from shocks. There is nothing of this, a properly laid line gives infinitely less danger, even with a high potential than that from explosions and fires by gas.

Now then let it be taken for granted that what the engineer has to do is to reduce the cost of his mains as greatly as it is possible. Our object then is to diminish this cost, and whenever we find that by diminishing the cost of our mains we are introducing a new engineering difficulty, then that is a problem for the engineer to overcome, and he must overcome it some way or other, if it possibly can be overcome, rather than increase the cost of his mains. Now there are three different reasons why it is objectionable to diminish the size of the mains too much: First, the great wasting in the energy which is used up by the resistance of those mains. We have to supply so much extra power in our central station in order to waste much simply by the heating of those mains, and that means an annual expenditure of a certain sum of money, whereas if we had made the mains a little thicker, we should not be wasting so much energy, and therefore in the primary outlay of a certain sum of money we should be saving an annual expenditure. The question is, of course, to balance these two matters in such a way that we arrive at the most economical result.

Now let us just look at the problem with a few figures before us to see on what scale we are dealing. Suppose that we are using a conductor of a square inch section to carry 1,000 amperes. The resistance of 100 yards of that conductor of pure copper would be ·0024 of an ohm. Now the energy which is used up is given you by the calculation $c^2 R$ divided by 746. That is equal to 3·2 horse-power used up in every hundred yards of our conductor for every thousand amperes. Now what is the cost of this electrical horse-power per annum? It is usually considered safe to say a horse-power costs £10 per annum, but owing to the period in which electricity would be used that is not a safe figure. Let me begin by considering £20 as the cost of horse-power. £64 is the cost of the total horse-power. We have wasted in four years in every hundred yards £256; in twenty years £1,280 is wasted in that conductor. Now, if I double the size of my conductor, I have the quantity of power wasting reduced to £640. The question comes to me, would it cost more than £640 of capital to lay down an extra hundred yards of a similar section? No, it would not, and therefore it is economical to double my conductor. And so we go on, step by step, until we find that the gain is just equal to the extra expenditure of capital in the laying down of conductors, and then we have arrived at a satisfactory arrangement. You will easily see if you work this out. Now this is an important point, in fact one of primary importance. It was first approached by Sir William Thomson in an address to the British Association in 1881, in which he read a paper on "The Economy of Metal Conductors of Electricity," and in a most interesting paper he arrived at the conclusion that the interest on the capital spent upon the conductors should be equal to the value of the energy which is wasted annually in these conductors.

The first question which becomes a trouble is, what are we to consider the cost of electrical horse-power? There are two ways of looking at this problem, and we will just glance at them independently. First, let us take the case of an installation which has been thoroughly carefully estimated for, and let us see there, after the whole of the buildings, distributing and supply plant, and everything has been laid down, what is the cost of each horse-power of electricity, if you like to call it so. To give you a perfectly unbiased example, I have taken the figures, kindly furnished by Mr. Crompton, of a large installation which he carefully prepared estimates for. I find, on looking into this, that in this case the cost of electrical horse-power—of course, depending on the number of hours used during the year—if it was for 1,000 hours, the cost of horse-power came to about 5d.; for

* Cantor Lecture delivered by Prof. George Forbes at the Society of Arts, February 2nd, 1885.

TABLE I.

B.W.G.	Diameter in inches.	Section in square inches.	lbs. copper per 100 yards.	Resistance per 100 yards at 15·5° C., or 60° F.		Wire heated to 9° above temperature of air.		Wire heated to 23° above temperature of air.		Diameter in inches.	(B.W.G.
				B. A. Units.	Legal Ohms.	Current.	Loss in volts. per 100 yards.	Current.	Loss in volts. per 100 yards.		
	2·26	4·0	4608·	·000634	·000627	1514·	·998	2490·	1·730	2·26	
	2·11	3·5	4032·	·000724	·000716	1384·	1·042	2246·	1·783	2·11	
	1·95	3·0	3456·	·000845	·000835	1228·	1·079	1995·	1·847	1·95	
	1·78	2·5	2880·	·00101	·000999	1072·	1·125	1739·	1·931	1·78	
	1·60	2·0	2304·	·00127	·00126	913·	1·205	1482·	2·059	1·60	
	1·38	1·5	1728·	·00163	·00161	732·	1·288	1188·	2·187	1·38	
	1·13	1·0000	1152·	·00253	·00250	542·1	1·426	880·0	2·446	1·13	
	1·00	·7854	904·78	·00326	·00324	451·5	1·513	732·7	2·586	1·0	
	·75	·44178	508·93	·00584	·00578	293·0	1·746	475·5	2·991	·75	
	·707	·39250	452·16	·00653	·00651	268·0	1·800	435·2	3·081	·707	
	·500	·19635	226·18	·01307	·01292	159·4	2·139	258·6	3·659	·500	
0000	·454	·1618	186·39	·01567	·01550	138·1	2·248	224·1	3·854	·454	0000
000	·425	·1419	163·47	·01786	·01766	125·1	2·323	203·0	3·977	·425	000
00	·380	·1134	130·64	·02236	·02211	105·7	2·456	171·4	4·201	·380	00
	·354	·09842	113·37	·02605	·02576	95·1	2·546	154·3	4·357	·354	
0	·340	·09079	104·60	·02824	·02793	89·4	2·594	145·1	4·442	·340	0
1	·300	·07068	81·42	·03637	·03597	74·0	2·755	120·1	4·722	·300	
2	·284	·06334	73·00	·04048	·04003	68·63	2·850	111·4	4·880	·284	
3	·259	·05268	68·68	·04867	·04823	59·60	2·981	96·7	5·102	·259	
4	·238	·04448	51·61	·05764	·05700	52·37	3·102	85·0	5·315	·238	
5	·220	·03801	43·78	·06740	·06665	46·5	3·213	75·5	5·521	·220	
6	·203	·03236	37·27	·07937	·07849	41·27	3·360	66·97	5·762	·203	6
7	·180	·02544	29·3	·1006	·08943	34·31	3·553	55·69	6·084	·180	7
8	·165	·02138	24·62	·1199	·11857	30·25	3·728	49·09	6·384	·165	8
9	·148	·01720	19·81	·1492	·14643	25·28	3·878	41·03	6·630	·148	9
10	·134	·014102	16·25	·1812	·17919	22·12	4·133	35·90	7·075	·134	10
11	·120	·011309	13·00	·2267	·22418	18·74	4·366	30·41	7·473	·120	11
12	·109	·009331	10·74	·2748	·27175	16·25	4·589	26·38	7·857	·109	12
13	·095	·007088	8·16	·3617	·35769	13·09	4·866	21·25	8·332	·095	13
14	·083	·005410	6·23	·4739	·47064	10·84	5·280	17·58	9·031	·083	14
15	·072	·004071	4·68	·6298	·62281	8·723	5·646	14·14	9·652	·072	15
16	·065	·003318	3·82	·7727	·76412	7·481	5·931	12·14	10·169	·065	16
17	·058	·002642	3·04	·9711	·96032	6·371	6·354	10·24	10·771	·058	17
18	·049	·001885	2·07	1·3598	1·3447	4·876	6·813	7·95	11·691	·049	18
19	·042	·0013854	1·60	1·8502	1·8297	3·883	7·485	6·31	12·658	·042	19
20	·035	·0009621	1·108	2·6650	2·6354	2·953	8·087	4·80	13·866	·035	20

Legal volts, 96 per cent. conductivity; copper-heating of bare copper wire, emissivity = ·00025 C.G.S units.

TABLE IIa.—Section per Thousand Amperes in Inches.

Annual Cost of Electrical Horse-power. £	1	1·1	1·2	1·3	1·4	1·5	1·6	1·7	1·8	1·9	2	2·1	2·2	2·3	2·4	2·5	2·6	£
5	1·628	1·356	1·147	·980	·857	·746	·658	·585	·523	·471	·426	·386	·355	·324	·298	·276	·255	5
6	1·954	1·627	1·377	1·176	1·028	·895	·790	·702	·628	·565	·511	·463	·426	·389	·358	·331	·305	6
7	2·279	1·898	1·606	1·372	1·199	1·044	·921	·819	·733	·660	·596	·540	·498	·454	·417	·386	·356	7
8	2·605	2·169	1·836	1·568	1·370	1·194	1·053	·936	·838	·754	·682	·618	·569	·518	·477	·442	·407	8
9	2·930	2·441	2·065	1·764	1·542	1·343	1·185	1·053	·942	·848	·767	·695	·640	·583	·536	·497	·458	9
10	3·256	2·712	2·295	1·960	1·713	1·492	1·316	1·170	1·047	·942	·852	·772	·711	·648	·596	·552	·509	10
11		2·983	2·524	2·156	1·885	1·641	1·448	1·287	1·152	1·037	·937	·849	·782	·712	·656	·607	·560	11
12			2·754	2·352	2·056	1·790	1·580	1·404	1·256	1·131	1·022	·926	·853	·778	·715	·662	·611	12
13				2·548	2·227	1·940	1·711	1·521	1·361	1·225	1·108	1·004	·924	·842	·775	·718	·662	13
14					2·398	2·089	1·843	1·638	1·466	1·319	1·193	1·081	·995	·907	·834	·773	·713	14
15						2·238	1·975	1·755	1·570	1·414	1·278	1·158	1·066	·972	·894	·828	·764	15
16							2·106	1·872	1·675	1·508	1·363	1·235	1·137	1·037	·954	·883	·814	16
17								1·990	1·780	1·602	1·448	1·312	1·208	1·102	1·013	·938	·865	17
18									1·884	1·696	1·534	1·390	1·279	1·166	1·073	·994	·916	18
19										1·790	1·619	1·467	1·351	1·231	1·132	1·049	·967	19
20											1·704	1·544	1·413	1·296	1·192	1·104	1·018	20

Annual Cost of Electrical Horse-power. £	2·7	2·8	2·9	3·0	3·1	3·2	3·3	3·4	3·5	3·6	3·7	3·8	3·9	4	4·5	5·0	5·5	6·0	£
5	·237	·221	·206	·192	·180	·170	·160	·150											5
6	·284	·265	·247	·230	·216	·203	·192	·180	·170										6
7	·331	·309	·288	·269	·252	·237	·224	·210	·199	·108									7
8	·378	·353	·329	·307	·288	·271	·256	·240	·227	·215	·203								8
9	·426	·397	·370	·346	·324	·305	·288	·270	·256	·242	·229	·217							9
10	·473	·441	·411	·384	·360	·339	·320	·300	·284	·269	·254	·241	·220						10
11	·520	·485	·452	·422	·396	·373	·352	·330	·312	·296	·279	·265	·252	·240					11
12	·568	·529	·493	·461	·432	·407	·384	·360	·341	·323	·305	·289	·275	·262	·206				12
13	·615	·573	·534	·499	·468	·440	·416	·390	·369	·350	·330	·313	·298	·283	·224	·181			13
14	·662	·617	·575	·538	·504	·475	·448	·420	·398	·379	·356	·337	·321	·305	·241	·195	·162		14
15	·710	·662	·617	·576	·540	·509	·480	·450	·426	·404	·381	·362	·344	·327	·258	·209	·174	·147	15
16	·757	·706	·658	·614	·576	·542	·512	·480	·454	·430	·406	·386	·366	·349	·275	·223	·186	·156	16
17	·804	·750	·699	·653	·612	·576	·544	·510	·483	·457	·432	·410	·389	·371	·292	·237	·199	·166	17
18	·851	·794	·740	·691	·648	·610	·576	·540	·511	·484	·457	·434	·412	·392	·310	·251	·209	·176	18
19	·899	·838	·781	·730	·684	·644	·608	·570	·540	·511	·483	·458	·435	·414	·327	·265	·220	·186	19
20	·946	·882	·822	·768	·720	·678	·640	·600	·568	·538	·508	·482	·458	·436	·344	·279	·232	·196	20

2,000 hours in the year, 3·5d.; and for 3,000 hours only 3d.; and that means, for the year in these three cases it would be 5,000 pence, 7,000 pence, and 9,000 pence. Now the next question that comes before us is, what is the number of hours we are supposed to use our electricity? There is very little doubt that about 1,000 hours is probably a fair average consumption of people in a town; but I think it very likely that, at any rate, in the first installation set up a certain selection will be possible, which will raise the average a little higher. For my own purposes at present, I am going to assume 1,500 hours; if you prefer another value you can work it out yourself to suit it. That will be the average cost of those two, which comes almost exactly to £25 a year. Now if you work out the cost of the energy wasted in a 1,000 yards conductor, you will find, I think, that the following figures are energy wasted in the conductor for 3½ inches, 4 inches, 4½ inches, 5 inches, 5½ inches, 6 inches, and 6½ inches; the amount is £22·8, £20, £17·8, £16, £14·5, £13·2, and £12. Therefore, the gain in passing from this to this is 2·8, 2·2, 1·8, 1·5, 1·3, and 1·2. These are the gains which there are in increasing the size of the conductor. Up to this point it is all plain sailing, a matter of plain calculation. The next thing is, what is the interest on the capital which is expended? This, of course, depends on the way in which the mains are laid, and different people have different ideas about how they should be laid. Many people lay mains at present with stranded cables. For my own part, I cannot see what is the object of doing this; it is the most expensive form in which you can produce your copper, and really nothing is to be gained. It seems to me simply to arise from the fact that cables we used previously were submarine cables, and certainly they are of great advantage there; but why they should be used on land, where there is no strain, I see no earthly reason. Others think they should be laid in massive bars of semi-circular shape, covered with bituminous compound; others that in flat sheets laid in troughs. At any rate, every person differs from every other, and consequently every person must have a different value for his cost of copper. But I have taken it as an example, simply, and you need not take the value I use. Take the £100 a ton as the cost of adding an additional amount of copper to our mains, after the troughs and so on have been laid. In that case the interest upon it depends upon the percentage which we allow. Now, what are we to allow? Ought it to be 5, 7½, or 10? That, again, is a question for the engineer to determine for himself. But allow me to point this out, when we are increasing the size of our mains, really we ought to be diminishing the percentage allowed for maintenance. The wear and tear is less, heating is less, the danger to insulation is less, everything leads us to believe there is a less cost of maintenance with a large conductor than with a small. This is a very important point. Each one must judge for himself whether to take 5, 7½, or 10. He will find with 5 per cent. the annual cost is 1·27, at 7½ per cent. 1·91, at 10 per cent. 2·55; so that what we have to do is to find that size of conductor which should equal the interest which we happen to consider the right interest. Supposing 5 per cent., then we have 1·27 settled, which gives 6 inches; 7½ per cent. 1·91, about 4 or 4½ inches; and 10 per cent. 2·55; between 3·5 and 4 inches for a thousand ampères. I have gone through this example carefully, just to give you a clear conception of the way in which the problem is to be worked out, but I think you may very safely say that the consumption I have taken is too large. It is perfectly true that in this estimate to which I have alluded is included the cost of buildings, engines, dynamos, boilers, and other machinery, the mains, and also includes the annual cost of coals at 18s. per ton. Well, all these points do come in, therefore it is a question for each one to consider for himself how far these things are to be divided in this way. It may be said by some, however, that it is desirable only to look upon our plant as being fixed, and supposing we want to carry extra current on the same size of conductor, would it be wise to do so or not?

I may now draw your attention to a table which I have drawn out for these lectures, which I have found of great use already, and which I believe all electrical engineers will find of use, too.

The engineer can choose his facts for himself absolutely, can choose what he considers to be the right value of the electrical H.P. every year for the number of hours he proposes to run. He can also choose the cost of copper which he thinks it will suit him to lay. Having done that he proceeds in this manner: I will take as an example copper costing £100 a ton; take 7½ as the rate of interest; I look along the column of Table II*b*. until I find £100, look down until I come to 7½ and find the figure ·386. I then look to the top of the Table II*a*. and I have £8 a year, say, for my electrical H.P. I look along the column of £8 a year until I find the figure nearest to ·386 and I find that it comes to a place beneath the number 2·7; in that case 2·7 would be the square inches which are required for the main on those conditions imposed by the engineer himself. I have given another table for continual reference, giving the resistance of 100 yards and various other facts, also the current which will heat the wire.

Before leaving the subject of the cost allow me to once more impress upon you that I consider this matter of primary importance and no considerations must ever lead the engineer to deviate from the strict rules which regulate the cost. It may be in some special cases not always practicable to regulate our wires to carry the current exactly at this rate. It may be because it is easy to get a stock of conductor of a slightly different size, or it may be inconvenient to be always varying the estimate in the size. But these principles must be gone into for every part of the scheme, and in our practical application we must stick as closely to our results arrived at there as we possibly can. It is no use for the engineer to say financial people will not bring forward the money for these costly mains. The engineer, in my way of looking at it, has no right to look at what the financier wants to do. He must tell them honestly what is the most economical thing to do. If the financier wants to lay out capital in a particular direction knowing that he will be causing a waste of energy, the engineer ought to have nothing to do with such matters. He ought honestly to give the value of the current which is most economical.

I have dealt now fully enough with the first cost that prevents us from diminishing the thickness of our conductors. The second cause why we should not reduce too much is the heating of the conductors. There are in this three injurious facts—in the first place it spoils the insulation; the insulating power of the material diminishes by being heated, and the material itself becomes injured; moreover, when it is hot it usually becomes soft and the conductors can sink into it and so become decentralised. And in the second place the conductors themselves are injured, because their resistance is increased by the increase of temperature, and these increases of temperature, mark you, are very considerable. And in the third place the increase of temperature may be very serious, and may actually be objectionable along the streets. I have here a small piece of cable which shows the decentralising action of bituminous compound. This has been lying for six or eight months in a cool part of a cool room, always lying in the same position. I believe when I got it it was perfect, but in a cool place it gradually sunk and now it is very decidedly out of centre. An old experiment which I used to show when I held my chair at Glasgow illustrates the viscosity of objects. It was first suggested to me and I first saw it done by Sir William Thomson in his laboratory. By taking hard, brittle pitch—or shoemaker's wax would serve the same purpose—take a block of it, put a bullet on the top and corks underneath; in six months the bullet will have sunk into the block and the corks will have risen several inches up through it. This simply shows you how such bituminous compounds must be carefully watched, and how very objectionable is any viscous material in the way of decentralising the conductor.

Now as to the question of heating conductors, I will not take up much of your time this evening, because I have already in a lecture which I gave at the Society of Telegraph Engineers last year, gone into the question very fully.

I only draw your attention to the question now because there is an important point which I am glad to say needs correction. A discovery has been made of an error near the end of the paper which might be misleading, and which probably has misled some. I will give you a corrected edition of it.

Here is the table to which I have referred. It gives you underground conductors. I have recommended sheets of copper for underground conductors, because the temperature is far less raised when you have a thin conductor.

Width in inches of copper conductor 1 cmr. thick.	Cross section in square inches.	Current to raise surface temperature 10° C. ampères.
3·2	0·25	250
12·7	0·98	1,000
38·1	2·95	3,000
63·5	4·92	5,000
127·0	9·84	10,000
889·1	68·88	70,000

This is a most important point. We have absolute control over the temperature; by widening out our sheet we have diminished temperature, and can make the heat of conductors subservient to economy.

I pointed out that if you do not bury your conductors more than about two feet the surface temperature is not affected; only the temperature of the conductor. If you go two feet deeper you will affect the surface temperature also. I have thought that up to 10° centigrade is the limit endurable by foot passengers. In the summer the rising temperature of the pavement is most objectionable; fortunately this is the time when the current is least used. Moreover the temperature does not immediately pass through the ground. The daily variations of surface temperature differs as the diurnal change of position of the sun: it does not penetrate very deep down—is very slightly perceptible at two feet depth. And if we have 500 amperes flowing for 24 hours, the effect would be almost exactly the same as if 1,000 amperes were flowing for six hours. Another point, if instead of laying a sheet one centimetre thick, you might lay cables with the same result provided the average thickness was one centimetre.

In speaking of the economical size of conductors, I arrived at the conclusion that I must use 2·7 inches, or say 3 inches for 1,000 amperes; but mark you, though 1,000 amperes is the average current, it is not the maximum current to pass through that conductor. The maximum is a very different thing indeed to that. When we have an average of 1,000 amperes it does not in the least mean that that is the average quantity of current which is flowing through it, because the wasted energy depends upon the square of the current. This leads to a very different law, and a very important one, about which I have a word or two to say. Suppose n_1 is the number of hours during which a quarter of the lamps are burning, n_2 one-half, n_3 three-quarters, and n_4 the number of hours during which all the lamps are burning.

TABLE II*b*.

Per centage allowed for Interest and depreciation per annum.	Cost of Laying One Additional Ton of Copper.																				Per centage allowed for interest and depreciation per annum
	£60	£65	£70	£75	£80	£85	£90	£95	£100	£110	£120	£130	£140	£150	£200	£250	£300	£350	£400	£450	£500	
5	·154	·167	·180	·193	·206	·219	·231	·244	·257	·283	·309	·334	·360	·385	·514	·643	·772	·900	1·029	1·157	1·286	5
7½	·231	·251	·270	·289	·309	·328	·347	·366	·386	·424	·463	·501	·540	·579	·771	·964	1·157	1·350	1·543	1·736	1·929	7½
10	·308	·334	·360	·386	·411	·437	·462	·488	·514	·565	·617	·668	·720	·770	1·029	1·286	1·543	1·800	2·057	2·315	2·571	10
12½	·385	·418	·450	·482	·515	·546	·578	·610	·643	·707	·772	·835	·900	·964	1·285	1·607	1·929	2·250	2·572	2·893	3·205	12½
15	·463	·501	·540	·578	·617	·656	·694	·733	·771	·849	·926	1·003	1·080	1·155	1·543	1·928	2·314	2·700	3·086	3·471	3·857	15
20	·616	·668	·720	·771	·824	·875	·925	·976	1·029	1·131	1·235	1·336	1·440	1·540	2·056	2·571	3·089	3·600	4·115	4·629	5·144	20
25	·771	·835	·900	·964	1·028	1·093	1·156	1·221	1·285	1·415	1·543	1·671	1·800	1·925	2·572	3·125	3·857	4·500	5·143	5·786	6·430	25

$$\text{Ratio of } \frac{\text{average}}{\text{maximum}} \text{ current.}$$

n_1	n_2	n_3	n_4	a
0	0	0	1	1·000
0	1	0	1	0·790
1	2	2	1	0·744
1	1	1	1	0·685
2	2	1	1	0·604
0	2	0	1	0·500

Then the average quantity can be got from the maximum quantity by multiplying all these fractions. If half the lamps are burning two-thirds of the time and the rest of the time all the lamps are burning, we get a equal to ·5. Therefore, instead of having 2·7 we only have 1·35 as the sectional area for 1,000 amperes. As a matter of fact I shall select for the rest of the lectures the quantity 1·5 square inches to the maximum current of 1,000 amperes. It seems to me for a working hypothesis, which no one need adopt, a good enough value.

The third reason why we cannot reduce the size of the conductors too much is that the potential falls, and the thinner the conductor the greater the fall of potential between the dynamo and the lamps. With a large current there is a great fall of potential (experiment shown), thus showing that in a central lighting station the fall of pressure, and therefore the brightening of the lamps in the district, depends upon the number of lamps in use at the time. This is a serious thing, and the most difficult engineering problem with which we have to deal. We have arrived at the consideration that a square inch and a half for 1,000 amperes is the size we must use, that means a fall of potential of 1·6 volts for each conductor in every 100 yards, that is to say, a fall of nearly 3¼ volts with the double conductor for a distance of 100 yards, and whether you like it or not you must have it. It may be met by making distant consumers use lamps requiring a different pressure to those nearer. This is the thing which has given most trouble, and the point will be considered in the next lectures.

I had hoped to have gone a little into a description of systems of laying mains which have been already adopted, but time is pressing too much. I will just say a few words about some of the systems I saw at the Philadelphia Exhibition last year. People seemed to have missed altogether the point that is to be aimed at in underground conductors. There was a list of inventions shown, simply consisting of tiles with holes through them, the cables to go through the holes. For low potential work it is not such a very difficult thing, and there has been a fair trial.

Edison's Conductors.

Outside in inches.	Area of one conductor in circular mils.	Maximum current in amperes.
3·5	1,639,890	1,400
3·0	862,976	760
2·25	262,951	370
1·31	107,289	220
1·05	33,000	100

These are laid in bituminous compounds in iron pipes, and seem to work pretty well for low potential work, but every electrical engineer thinks we shall be able to introduce high potentials some time or other, and reduce the cost of these mains.

What is it that makes it so difficult to insulate these mains properly? It is very difficult to say. It may be that there is a faint leak, and a spark passes to the iron pipe in which the conductors are encased and that gives rise to an increasing leak. It may be that where there is the faintest leakage there is a partial decomposition of the water that comes into contact with it and that brings electrolytic action into contact with the insulating material, which we know it generally destroys and so the leak becomes worse and very bad indeed. Through the kindness of the Brush Company I have here a specimen of a fault in one of their underground city conductors showing where it is eaten into. In Philadelphia there were some systems shown in which there was a very wide trough and glass plates introduced here and there, in which was a large number of holes. Glass is a very bad substance to use; it gets such a moisture upon it that I should not have thought it was the best thing to use, and beside there is a tremendous wasting of space for small wire. In another, copper rods were carried through pipes made as water-tight as possible, supported on rings of glazed porcelain so that there is a very small surface of leakage possible. With the rings here and there of course dampness was a serious obstacle; and in this system it was proposed to blow dry air through the pipes so as to keep the moisture continually out of them. I can only say of this that it is only a proposition, the thing has never been done.

I had hoped to speak to you of what has been done in underground conductors, but really there is very little to tell you and that can be said in very few words. In Philadelphia there was a system of underground conductors put down by the Excelsior Company, and they worked pretty well. They used large troughs and where there are large troughs there is no difficulty about it. But these large troughs had very serious inconveniences that one hardly expected from electricity. Three times during the time I was at Philadelphia the troughs in Chestnut Street blew up, a most unexpected result from an electric conductor, but it was a positive fact, and the secret was they were too near the gas mains, which leaked and positively filled the troughs and consequently they blew up. However, these were accidents that might have been prevented with care.

I have an illustration here of the installation at Colchester, which illustrates the way in which very large troughs are laid with conductors cut along them.

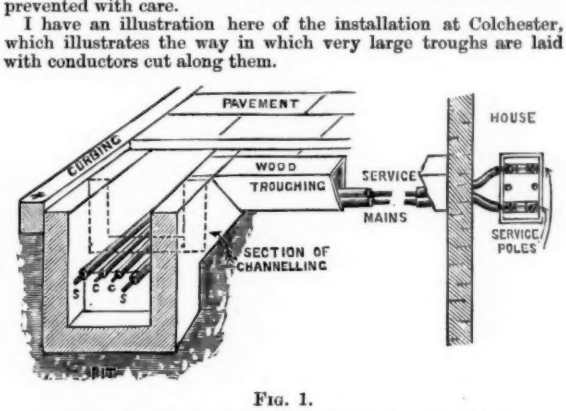


Fig. 1.

Channelling Showing Charging and Supply Cables.

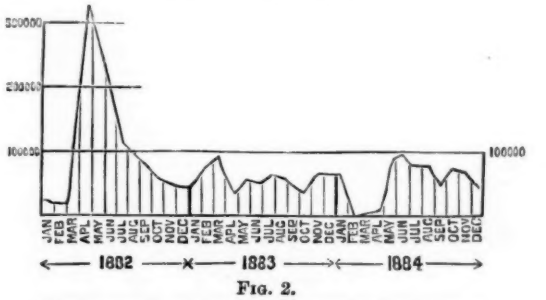

200000
100000
100000
JAN FEB MAR APL MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APL MAY JUN JUL AUG SEP OCT NOV DEC JAN MAR APL MAY JUN JUL AUG SEP OCT DEC
1882
1883
1884

Fig. 2.

Insulation Resistance of Underground Cables.

The Jablochkoff Company on the Thames Embankment has had a lengthened experience extending since 1878, with a small $\frac{7}{16}$ strand wire covered with gutta percha and tape and put in troughs underground, where it has given very little trouble. Then,

again, in the city the Brush Company has had these conductors underground since April, 1880, and they have had a great deal of trouble. They tell me that they were put in first very loosely and covered with sand for some reason or other, and in drawing the cables through the pipes the sand wore them away and the consequence was the insulation went.

Here is a curve showing the insulation resistance of these cables extending over a lengthened period. The variations of the curve indicate continual cases of faults being discovered. This is a very instructive curve, and shows the difficulties of working with conductors simply laid in the ground in that way. I have no doubt that other people have had large experience with high potential conductors, and I wish I could have succeeded in getting a larger number of facts to put before you, but unfortunately I have not come across them. This lecture is simply preparing the way for the consideration of different systems of laying conductors. In succeeding lectures we shall see how engineers have attempted to get over the problem of fall of potential, and how to combine economy with efficient working.

THE ELECTRIC LIGHTING ACT.

Deputation to the Board of Trade.

On Thursday afternoon, at Whitehall Gardens, Mr. Chamberlain, President of the Board of Trade, received a deputation from the Dynamicable Society, with reference to the Electric Lighting Act, 1882. A committee of the Society has prepared a report on the subject, upon which we have previously commented, and this report was submitted to the Board of Trade authorities for their consideration. The deputation was introduced by Viscount Bury, and consisted of the following:—Professor Grylls Adams, Professor George Forbes, Dr. W. H. Stone, Messrs. C. E. Spagnoletti, W. H. Massey, Musgrave Heaphy, R. E. Crompton, Latimer Clark, Arnold White, R. H. Milward, F. R. Reeves, F. L. Rawson, F. H. Webb, and W. D. Gooch, hon. sec. of the Society.

Viscount Bury, in introducing the deputation, read letters from Sir William Thomson, the President of the society, Professor Fleeming Jenkin, and Dr. J. Hopkinson, apologising for their absences from causes beyond their control. The deputation, he reminded Mr. Chamberlain, had great weight electrically, and he would like to add that they did not appear before him so much in their capacity as electricians as in their capacity as a consulting body of electricians who wished to represent as far as possible the general public in this matter, and the report they presented they desired to be received as an expression of the views of the general public as they would be expressed if the public possessed the requisite electrical knowledge. They did not represent the scientific body of electricians, and in a still greater degree they did not represent the commercial element as constituted by the companies. They knew that the Electric Lighting Act was framed with a great deal of care, and upon the best information which was available at the time. For himself he must confess he thought it had done a great deal more good than harm; but owing to the circumstances under which it was prepared there were certain clauses in it which in their opinion must be either remodelled or repealed before electric lighting could become anything like generally accessible to the public. Their object had been to find what changes would be necessary in order to remove any obstacles which stood between electric lighting, which they already saw to be an accomplished fact, and its enjoyment by the public. They thought there were two main alterations which might be made; one, the repeal or the great remodelling of the 27th clause, regarding the purchase by municipal corporations and others of the electrical plant of undertakers, and the other with regard to the use of electricity. At present under the Act it was necessary that meters should be used. Without denying—of course as electricians they could not deny—that there were meters, yet they had not been proved; they did not yet know how they would work in general practice. They did not believe that it was outside the resources of electricity to produce a meter, but they did say that meters had not been proved to be thoroughly trustworthy, and they must not rely upon meters and must allow those supplying electricity to make their own arrangements as to the way in which it should be supplied. He was desirous of impressing the fact that, representing the general public, they did not wish that anything which they did should be construed as favouring a new cropping-up of gambling in electric shares. It was possible that when changes were made the public might again be appealed to to subscribe a great deal more money. Whatever might be the case in that respect, they wished to dissociate themselves with any such thing. He had spoken to Lord Thurlow, the chairman of the other committee considering this question, who agreed with him that this was a possible danger and said he would view such a state of things with great dissatisfaction. He (Mr. Chamberlain) had had before him for a considerable time the report of the committee of the Dynamicable Society, and had no doubt done them the favour of reading it. They knew that he was very much interested in the question, and they approached him with perfect confidence that he would do justice, at any rate, to the motives of the society and act with a sincere desire to do the best he could towards electric lighting.

Mr. Milward said he had been asked to speak respecting the 27th clause of the Act, and the time in which purchase should be made, if any purchase were made, by local authorities. The question of the 27th clause was of the greatest possible financial importance, because upon its working depended the question whether or not electric lighting could be carried out publicly to a profitable point. He thought it was a principle of the Board of Trade, as well as of every other controlling party, that whilst no undue advantage should be obtained by undertakers from any monopoly or from any compulsory powers over streets, towns, or houses, neither should any undue limitations be imposed upon their undertaking in the sense that they were thereby deprived of the possibility of earning a reasonable, fair, and average profit upon the capital they might have engaged in that undertaking. Starting from that as a principle, his object was to show that either a term of 21 years was too short a term, or the conditions upon which the purchase was to be made were too onerous. The term of 21 years could not be considered as an entire term in which dividends could be earned, because the term did not commence from the date at which the order came into operation, but from the date of the passing of the Act confirming the order. Therefore from that term of 21 years must be subtracted, first, the necessary time to enable the undertaking to be got into working operation, the company to be formed, the capital to be subscribed, prospectuses to be issued; and, further, the necessary time for the commencement and completion of those works from which the dividend was to be earned; in addition must also be subtracted the waiting time absolutely necessary to induce the consumer to give in his allegiance to the project. He thought, therefore, that in deducting two years from the 21 he was not deducting an outrageous time. Then the sum became a simple rule of three. The powers of the local authority to purchase were most conservative. They provided that no improper sum should be paid, and, in fact, that a great deal should be deducted from the expenditure made by the undertakers, from the expenditure in obtaining the Act of Parliament, all preliminary expenses, all engineers' preliminary expenses, all charges on machines which at the time of purchase had worked themselves out or had been replaced by newer or more efficient machines. All these items taken together would no doubt make a very considerable inroad into the capital of the undertakers, and a sinking fund of one-half of the capital originally expended would have to be provided by the undertakers. An annual sinking fund necessary to produce a given sum in nineteen years would be regulated according to the amount on which interest could be made. He took it that £1 per annum invested at 3 per cent.—and they could not provide for a larger rate of interest—would amount to £25 at the end of nineteen years. Therefore, assuming an installation in which 5,500 lamps would be provided at a cost of £60,000, £30,000 would have to be provided as a sinking fund at the end of nineteen years, and for this a sinking fund at the rate of £1,200 a year would be necessary. The average consumption of electricity per lamp would not exceed 1,000 or 1,200 hours per annum. As far as his experience went, the consumption at that rate for an ordinary gas burner for that time cost, with the price of gas at Birmingham, 13s. 6d. per annum. Therefore it followed almost as a matter of course, that if the larger price were charged to the consumer of from 25s. to 30s. for his electric light he would not take it. Assuming that they found a consumer willing to pay 30s. per annum for that for which he had been paying 13s. 6d., and taking the working expenses of the 5,500 lamps, it would be found that the sinking fund would be so large that it would leave, practically, a very small gross rate of interest upon the capital expended. He had worked out the calculation on the £60,000 capital, and he found there would be a gross return of 6 per cent. out of which to pay all establishment charges and dividends to shareholders. The result was this—these figures had been checked and worked out and gone to the bottom of over and over again, and had been submitted to the best investment brokers in the City of London and in the provinces, and the answer had been that unless they could obtain a prolongation of their term of 21 years it was absolutely impossible to ask the public to subscribe their money with any chance of obtaining their subscriptions.

Prof. Forbes said it seemed to him that the check which had been given to electric lighting was due to two causes, the first being that it was really impossible to hope for capitalists to subscribe money on the terms laid down by the Electric Lighting Act, and the other, that there were purely engineering difficulties. These difficulties were not insurmountable, but were much greater than was anticipated when the Act was introduced. This led him to two points in the report he wished to speak about. The committee considered that electric lighting would not be possible so long as undertakers were compelled to lay down mains for anybody who asked them; it was quite impossible to go to the enormous expense of laying down mains and generating plant for individuals who would only be using a very small supply of electricity, and therefore they considered if the public were to have the electric light even as a luxury—and it must be as a luxury for some time—this point must be yielded, and those who were inclined to take it must take it for a certain period. With regard to the 27th clause of the Act, the committee was unanimous in considering that eventually it would be necessary to put the electric light on the same footing as gas; and it certainly seemed to him to be very desirable, if they, after considering the matter as engineers and as intelligent persons, came to the conclusion that this was necessary, that they should appeal to the Board of Trade at the present moment and state their convictions than to seem to coincide with what they really did not believe and let it lie over for some years to be brought up on some future occasion. He

further contended that a monopoly was not likely to occur in the case of electricity, inasmuch as there was not the slightest chance of its ever absolutely ousting gas.

Mr. Arnold White spoke on the 18th clause, which precluded the undertakers from controlling the form of lamp. The lamp was essentially a part of an electric system, so essentially that it could not in any way be compared with a gas burner, and it was placed out of the power of the companies to know what pressure was placed upon the mains or what consumption was taking place if lamps other than those they made provision for were used. Another and more important reason was that in the future invention would be checked and the profits of new and far more economical lamps thrown into the consumers' pockets. Many improvements had been made since 1882, and there was no reason to suppose that those improvements had reached a stage of finality; in fact he might go so far as to say that, in the opinion of Mr. Edison, with whom he had conversed on the subject, there was no scientific reason why a form of lamp should not be produced which by the consumption of one-hundredth part of the current now used should give the same amount of light. An analysis of the evidence given before the Committee of the House of Commons showed that, whilst accurate as far as was known at that time, it did undoubtedly contain more than a trace of that spirit of enthusiasm which at that time had hold of the public mind. The Exhibitions at Paris and at the Crystal Palace gave the public the idea that they were in possession of things which not simply were in their infancy, but which did not exist at all. In the event of further evidence being taken it was most important that the House of Commons should go further a-field for the purpose of ascertaining the real facts of the case.

Mr. Crompton said the committee considered that whatever the Board of Trade did in helping them in this matter, they could themselves aid the cause of public lighting if greater facilities were at once given for the granting of licenses. That could be done by altering the form of the license of the Board of Trade, and they therefore asked that those licenses should be so remodelled as to make it a much easier and quicker thing to obtain them. They also asked that in cases where the local authorities were themselves suppliers of light they should not have power to veto the granting of licenses for electric lighting.

Mr. Chamberlain, in replying, after thanking the deputation for the information given him, said he had still to hear from other deputations who were interested in this matter. They were aware that Lord Thurlow brought there a number of gentlemen who were chiefly connected with the existing companies, and as a result he (Lord Thurlow) promised on their behalf to lay before him some practical proposals which the Board of Trade would consider. He had not received the proposal yet: he should like to compare them with those now brought before him. He was also told that the local authorities, who claimed to be interested in the matter and who also said they were not opposed—as he did not think anybody could be—to the extension of electric lighting, had intimated that they would like to be heard if there was any intention to alter the Act to their disadvantage. As to the minor suggestions made they would all receive his careful consideration. It was not to be supposed that any Act was entirely perfect, and if they could make alterations that did not affect the principle of the Act in the cause of progress they would do so. He did not think that he could accept the view put forward by Mr. Crompton. He was glad to have a suggestion for an improvement in the form of license, but to ask him to put aside the opinion of the local authority, a body fully competent to represent the whole population of a district, in favour of some private speculator, and insist upon enforcing upon a district an undertaking it did not desire, was to ask for what he thought would be going back upon the spirit and intention of the Act, and he could give them no hope that the request would be favourably considered. As to the question of lamps he admitted there was a good deal of difficulty, but he thought Mr. White should remember that that clause was inserted at the instance of one of the leading inventors and engineers connected with electric lighting. He believed it was Mr. Swan who urged most strongly that it would be extremely unfair if consumers who preferred his lamps should be forced to have some other lamp when it could not matter in the least to the person supplying the electricity. Still he admitted it was a serious matter, but he could not help thinking that the difficulty might be overcome by the scientific gentlemen connected with the undertaking, and there might be some means of differential charge, without so much interfering with the consumer as to insist on his taking a particular lamp. But after all the real point they appeared to have at heart was the question of the 27th clause. If he had only to consider the arguments and statements of Mr. Milward he should not have anything to say except to promise to give the matter the most careful attention. But he had before him also the report of the committee of the Dynamicables, which had been spoken on by Prof. Forbes, and that went much further. Mr. Forbes had said they would not ask too much, but he was bound to say they had asked for everything. What they had asked for—it was put rather ingeniously—was that they should be put on the same footing as gas. But that was impossible. Gas was subject to all kinds of restrictions which were not applicable to electric lighting, maximum price, sliding scale, and other things. In the second place, at present public opinion would not authorise the creation of a new monopoly after experience in the case of gas. Prof. Forbes said there would not be a monopoly because gas existed and would exist. They might as well say there was no monopoly in the case of gas whilst petroleum existed, for the consumption of petroleum had increased since the introduction of gas. There would always be competition of that kind; but, at the same time, it did not prevent gas from being found to be a most serious monopoly. He would speak to them frankly, for he did not wish them to be wasting their time on what appeared to him to be a fruitless undertaking. Their proposal was that they should be given for perpetuity a monopoly or right to sell their concern at, as they expressed it, a fair value as a going concern at any time. This might secure for any undertaking a most exaggerated and enormous price, as similar terms had already secured for other undertakings; and he must say he did not see the slightest chance of their obtaining this. There was nothing to prevent their obtaining—as he knew had been obtained—forty or fifty years' purchase of the profits, and there was nothing to limit the profits, because they would not only be entitled to have 25 years' purchase at the actual profit made, but would be entitled to claim for prospective profits due to the probable increase of the undertaking, and under those circumstances it meant forty or fifty years' purchase; not, perhaps, an unreasonable amount to demand, but an amount which he thought the ratepayers would think it unreasonable to have to pay. Mr. Milward had said that a sinking fund would be involved to provide for one half of the capital. He might say that he was most surprised to find that that would not be a heavier charge than Mr. Milward made it out to be. The figures given were 4s. 6d. per lamp—they expected to get 30s. a-year—which would be really a charge of 15 per cent. for sinking fund. This was perhaps a considerable charge, but going back to his own experience, some of the most important patents, involving an enormous expenditure of capital, had had to be subjected to a very much greater amount than that. He might say that if any fair proposal could be made which would secure to the undertakers a fair return upon capital fairly expended, in case the local authorities saw fit to take their business from them, it would be entitled to and would receive the most serious consideration. He conceded that there might be some special cases in which the terms of the Act would not give as much as that, and if the Society or any other persons interested in the matter would lay before him the terms which they thought should be inserted in the clause to give effect to the principle he should be very glad to consider them. It was pretty clear that any very large development of considerable installations was not to be expected under any Act of Parliament that might be devised, and under those circumstances he thought it would be the gravest pity if they were so to alter the Act as to justify a renewal of the speculation, which was not very creditable to those who took part in it. On these grounds, while he was quite willing to deal with any reasonable modifications that might be proposed and to endeavour to satisfy those interested in the matter, he did think it would hardly be politic to consider any very great modifications.

Lord Bury said that with respect to the licenses what the committee thought was that where the local authorities were themselves holders of provisional orders and therefore direct competitors, they should not have a veto, but that it should then rest with the Board of Trade.

Mr. Chamberlain replied that that was plausible, but after all they could not separate the local authority from the community, and if the community as a whole chose to say, "We do not want our gas undertaking to be destroyed by the introduction of a new undertaking," it was perfectly fair that they should have the power to veto.

Mr. Reeves: Then the minority would have no right.

Mr. Chamberlain: The minority would have the right, and would probably exercise it, of exerting very considerable pressure upon the local authority; and if they had a good case it would be impossible for the local authority to ignore it.

Mr. Crompton remarked that in London he had had many applications to light perhaps the side of a square or a number of houses, and for this it was necessary to get a license. This was the very experiment they wanted to carry out, the stepping-stone to more extended experiments; but he had been unable to get the licenses because of the opposition of the vestries.

Mr. Chamberlain: That is a practical question, and if you will bring me any case like that we will examine it and communicate with the vestry. Mr. Calcraft has reminded me that we have had one application from Lambeth that they should have an open license enabling them to agree with any undertakers, and we have agreed to grant it, extending therefore the discretion of the vestry, not requiring them to deal with the matter themselves, but enabling them at any time to deal piecemeal with their district by means of private undertakers.

Lord Bury having expressed the thanks of the deputation to Mr. Chamberlain for the courteous manner in which he had received them, remarking at the same time that they wished he could have given them a little more encouragement, the proceedings terminated.

The Electric Light at the New York Capitol.—The lighting of the Capitol with electricity has proved quite satisfactory. All the lights of the building are fed from powerful dynamos in the basement, which constitute the most costly local electric light plant in the country. The dynamos feed 61 arc and 1,386 incandescent lamps scattered throughout the great building.

NOTES.

To Our Subscribers.—It is particularly requested that in sending subscriptions by postal orders from countries (such as Belgium, Italy, Norway, Denmark, and India) from which the *postal authorities* transmit the order, a letter of advice be always sent us direct; otherwise we are prevented from ascertaining, and crediting the amounts to, the senders.

Street Lighting in Philadelphia.—Contracts for furnishing the City Electrical Department of Philadelphia with supplies for the ensuing year were awarded on January 10th. The United States Electric Lighting Company was awarded the contract for furnishing 26 lights on Delaware Avenue at 59½ cents per night, and the Brush Electric Light Company was given the contract for 17 lights on Poplar Street, between the Delaware River and Sixth Street, at 58½ cents per night.

Gas Triumphant at Dubuque.—We learn that the Electric Light Company of Dubuque, Io., finding that it was losing money at the rate of $1,000 per annum, has resolved to shut off the light, and offer the plant for sale at half-price. *Sic transit gloria*, and Dubuque progresses backward to the use of gas.

Lighting a Training Ship.—The Metropolitan Asylums Board is inviting schemes, specifications, and tenders for lighting by electricity the training ship *Exmouth*, now moored in the River Thames, off Grays, Essex. Tenders must be delivered by 14th February.

The Light at Hell Gate.—The electric light at Hell Gate went out on Saturday morning, January 3rd, at 4 o'clock. The stoppage was caused by the fact that a part of the screws attaching the armature to the shaft gave signs of being loose. The attendant engineer, noting this, decided that it would be advisable to cut off the light. Owing to the circumstance that there was a lack of proper tools, such as those which are in use at the Cleveland factory, the repairs occupied the time from Saturday until Tuesday. "Since the light was first placed at Hell Gate last November," said Mr. C. P. Whitney, secretary of the Brush-Swan Electric Light Company, to a reporter, "there have been no mishaps worth calling by the name. Once a couple of globes were broken by a bird and the lights went out. Of course the weather has once or twice occasioned annoyance. One night the lights went out owing to the presence of sleet on the elevator, which kept the attendant from going up. The government is perfectly satisfied with the apparatus and its workings, and the plant has been fully settled for." Mr. Whitney stated that a duplicate apparatus had already been ordered, so that such a delay in the electric lighting of Hell Gate could never occur again. "The original objection of the pilots," he said, "which was not very general, is, we are assured by the government officers, entirely removed. During the nights in which the lights were out there were many complaints from parties using the water about Hell Gate. Great regrets were expressed at the absence of the lights. Some of the captains of the Sound boats, I have been told, have concluded that it was a very great advantage to have the Hell Gate electric illumination, and that it was materially useful in navigation. It certainly is," concluded Mr. Whitney, "a permanent institution, and is now generally understood to be such."

An Electric Light Convention in America.—A convention of delegates, representing companies doing an electric lighting business in the United States and Canada, is to be held at the Grand Pacific Hotel, Chicago, on Wednesday, February 25th. Every electric lighting company in the United States and Canada has been invited to send delegates properly accredited.

Electric Lighting of a City Warehouse.—An installation of arc and incandescent lighting has been now running over a fortnight at Messrs. Sutton & Co.'s, carriers, Golden Lane, City. It consists of 12 Bowman compensating arc lamps and 30 Swan glow lamps of 20 candle-power. The dynamo used is a Gramme, made by Messrs. Stanley & Davies, of Hyde, and introduced through their London agent, Mr. C. R. Heap. To Mr. R. D. Bowman, of East Dulwich, belongs the credit of fitting up the above. Messrs. Stanley and Davies are now executing a large order for dynamos of the Gramme type from the Paris firm of Mildé et Fils, who are their representatives in France.

Electric Lighting for Steamers.—The Peninsular and Oriental Company's steamer *Carthage* has been specially fitted up for the purpose of bringing home the Duke and Duchess of Connaught from Bombay. Arrangements for lighting the ship by electricity were practically tested on Tuesday last.

The directors of the Richelieu and Ontario Navigation Company, Montreal, have decided that next season their boats will be illuminated by Messrs. Craig and Sons' electric lights.

The National Telephone Company, Limited.—Mr. John D. Miller, manager of the National Telephone Company's Aberdeen district, has been promoted to be manager of the Dundee and District Exchanges. Since Mr. Miller went to Aberdeen in August, 1883. the number of subscribers there has very largely increased, and the entire Exchange switchboard and standard arrangements have been altered and extended under his supervision. In the district to which Mr. Miller is appointed, besides Dundee, with nearly 700 subscribers, there are branch exchanges at Broughty-Ferry, Newport, Tayport, Forfar, and Perth, and others are to be formed at Arbroath, Montrose, &c. Mr. George J. Somerville, from Glasgow, will succeed Mr. Miller.

Later information is to the effect that on Monday last a number of the subscribers to the Aberdeen Exchange presented Mr. Miller with a beautifully illuminated address in token of their appreciation of his services whilst in Aberdeen.

Expensive Telephoning in Glasgow.—At the annual meeting of the Dundee Telephone Company, held on Wednesday, ex-Provost Moncur congratulated the shareholders on the position and prospects of the company. By means of this company Dundee was now the best and cheapest telephoned town in the kingdom, and he wondered Glasgow people should contentedly pay £20 per annum, seeing it had been demonstrated in Dundee that such facilities might be had at a much cheaper rate. A dividend of 5 per cent. was declared.

The McDonough Claims.—On the 15th ult., at Washington, the Commissioner of Patents began hearing argument upon the motion of McDonough, one of the parties to the interference case of Bell *v.* McDonough *v.* Gray and others, to refer back to the examiner of electrical devices McDonough's claim, with a view to showing that his invention was operative. The Board of Examiners in Chief set aside the decision of the Examiner of Interferences, which gave to McDonough priority of invention of the telephonic receiver, on the ground that his device was not practically operative.

Telegraph Revenue.—The receipts from April 1st, 1884, to January 31st, 1885, were £1,490,000; from April 1st, 1883, to February 2nd, 1884, £1,485,000.

New Telegraph Station in China.—The Great Northern Telegraph Company announces that a telegraph station has been opened at Pakhoi, and that telegrams for that place are now accepted for transmission by the company's lines at the rate of 10s. per word.

A Big Cable—One of the largest cables, if not the largest, in use in telegraph service underground, the *Electrical World* states, has just been laid in Boston, along Friend Street, from the Old State House to the Western Union Office. It is a kerite telegraph cable, 60 conductors, and contains over eight miles of wire, the distance between the two points being only 644 feet. The cable is run through a 3-inch wrought-iron pipe.

The Zanzibar-Mozambique Cable.—The Eastern Telegraph Company notifies the interruption of the South African Company's Zanzibar-Mozambique cable. Telegrams on hand for Mozambique, Delagoa Bay, Durban, and other places in South Africa were conveyed by the company's repairing ship to Mozambique.

The "Faraday."—The steamer *Faraday*, which is engaged in laying an extension of the Bennett-Mackay cable between Ballinskelligs and Havre, put into Berehaven at the beginning of the week in consequence of the severity of the weather.

The Fastnet Cable Reported Broken.—A violent north-westerly storm broke over West Cork on Saturday, attended by heavy showers of hail. The newly laid cable between Crookhaven and Lloyd's signal station on the Fastnet, which has been less than a fortnight working, was reported to be broken.

Cable Competition.—A Glasgow contemporary hears that there is every likelihood of another reduction in the rates to America immediately taking place. Since the Bennett-Mackay Company opened its cable, with an office in that city, and with rates much below those of the other cable companies, its success has been wonderful. This reduction has compelled the other companies to lower their rates also, and it is said that, to be able to compete on equal ground, each company will require a Glasgow office of its own. That the opposition is doing good is seen from the rapid transmission and delivery which is now effected. Five messages were shown the other day which had come from New York in less than 15 minutes, having been transmitted three times. It may be interesting to learn that the Bennett-Mackay Company—like the Eastern Company—rents a wire from the Post Office authorities. It sends its messages to Liverpool from Glasgow, thence forward to Waterville, in County Kerry, and from there direct to New York through its own cable.

An Electrical Railway Traffic Indicator.—A design has been invented for representing upon a large mirror all the traffic of a railway as it moves from station to station, and even from one mouth of a tunnel to the other. On the surface of the glass are represented the several lines under the control of the signalman and his neighbours. These appear as horizontal marks upon the glass, with small vertical interruptions indicating the stations. Along the lines pass little arrows which keep pace in their course with the movement of the real trains below, being set in motion by means of an electric arrangement in connection with the rails. As the trains pass over the rails they come in contact with metal brushes fixed at the side, and these communicate an electric shock to the motors of the signal plate, sending on the emblematic arrows along the glass. This is very pretty indeed, but somewhat impracticable, we imagine. If an arrangement could be devised so that the engine-driver, not the signalman, might be made aware of what was in front or behind his train, it would be more to the point. The principal result of the above invention, so far as we can see, will be that the signalman would have the grim satisfaction of observing a collision in miniature in his cabin when it occurred. If drivers do not pay proper attention to signals in the daytime, or cannot perceive them at night, we fail to see how this invention will enable a signalman to prevent accidents.

Electrical Units.—Mr. W. H. Preece has written to the *Electrical World* (New York), in reference to the remarks of the *Mechanical World* regarding the "watt" as follows:—"I regret to perceive that on two or three occasions you have extracted from a paper called the *Mechanical World* some strange and peculiar remarks about units of measurement. Until you mentioned that this paper was a London paper, I was labouring under the delusion that it was American, for I have never seen it nor heard of it except through your pages and those of the London ELECTRICAL REVIEW. I find on inquiry that this remarkable exponent of English scientific knowledge is produced in Manchester—the home of Joule. It is difficult to conceive how any paper that pretends to circulate knowledge can allow its pages to be sullied with such wretched rubbish. The writer has run amuck on the assumption that a watt is an electrical unit. It is the unit of power, however expended, and power is the rate of doing work. Whether it be a candle burning, a man rowing, a horse ploughing, a steam engine working, a windmill grinding, or a water-wheel sawing, the work done per second in each case can be expressed in watts. The watt is a fraction, $\frac{1}{746}$ of a horse-power, in the same way that a 'foot-pound per second' is the $\frac{1}{550}$ of the same quantity. Electric currents are the result of the expenditure of power, and since a watt is expended in maintaining a current of one ampère through one ohm, we have mechanical units and electrical units directly connected. A watt is in fact ·736 foot-pound per second. Hence we can say that a sperm candle expends 71·4 foot-pounds per second, and that a gas jet expends 46·37 foot-pounds per second per candle, but it is simplier to say in the one case 97 watts, and in the other case 63 watts. The watt is now a regularly accepted and recognised unit. It is remarkable how often sciolism veils itself in ridicule, but it is seldom that such crass ignorance as this *Mechanical World* exhibits has disgraced the pages of English scientific literature."

Telephonic Facilities.—Regarding the remarks which we reprinted recently from the *Times*, Mr. E. Dwyer Gray, Chairman of the Telephone Company of Ireland, writes:—"You complain on the part of the public that telephone call offices are not opened in London in telegraph offices, as in Paris, and you also complain of the rigid terms of the contract made by the telephone company with subscribers forbidding them to permit others to use the instruments. Permit me to say that a little time ago I, on the part of the Telephone Company of Ireland, applied to the Post Office for permission to open telephone call offices in branch post offices in Dublin. I was told that this could not be permitted by the Department, and doubtless the same rule applies to London. The rigid terms laid down by the telephone companies in their contracts with their subscribers are necessitated by the extremely rigid terms of the licences of the Post Office to the companies. I cannot myself see what but benefit to the business of the Post Office could result from permitting the telephone companies to open call offices at telegraph and post offices. But this, unfortunately, is not as yet the view taken by the Department. I am not without hopes that the officials of the Post Office may by-and-by consent to permit telephones to be placed in telegraph and post offices; but meanwhile it is only fair for the public to understand that the telephone companies are not responsible if this convenience is not afforded."

The Lalande-Chaperon Battery.—In reply to a request for information on this battery, a correspondent in the *English Mechanic* submits the following:—"Carbon" must not expect too much from his Lalande and Chaperon battery. I have had considerable experience during the last 18 months with above battery, and will give him the following data:—The initial E.M.F. of the battery is about 0·9 per cell, but unless put through an external, R, exceeding 20 ohms, it rapidly falls to 0·6, at which it is fairly constant. Therefore, you may calculate on getting a total E.M.F.

from your nine cells when joined up in series of 5·4 volts, which is not enough for your lamp. Further, you have a zinc surface per cell of only 34 square inches, and in actual practice 40 square inches of zinc surface are required per ampère of current at a distance of 1½ inches from the oxide of copper. Your cell will give you then, if the zinc be 1½ inches from the oxide of copper, 0·85 ampères. Now a 6 volt 3 C.P. lamp takes about 3 watts per C.P., requiring a total of 9 watts to light it. Your battery will only yield you under the very best conditions 0·6 E.M.F. per cell × 0·85 ampères per cell = 0·51 watts per cell, or for the nine cells 4·59 watts, or about half of what you require. To light your lamp you require 11 cells with zinc of about 6 inches in diameter. Always use E.M.F. in slight excess of what the lamp requires to get a good result. Also do not have a saturated solution of caustic soda, though it requires to be pretty strong. Do not use a brass connection to suspend the zinc in solution, but zinc only. If possible solder all connections. Do not switch the full current at first through the lamp, as the initial E.M.F. will break it; but put through either an adjustable resistance coil or short circuit the battery before going through the lamp for a few seconds. The advantages of the battery are:—1st. That on open circuit the local action is extremely small; 2nd. That when once charged the battery will give from 150 to 200 hours' lighting with no attention.

In re H. B. Binko.—In the Court of Bankruptcy last week the bankrupt, described as of Roscoe Street, Bunhill Row, chemical manufacturer and inventor, applied for his order of discharge. The liabilities were £3,535 and the assets £219. The Official Receiver reported that the bankrupt's books did not sufficiently disclose his business transactions for two years immediately preceding his bankruptcy, and that he had also filed a petition for liquidation in March, 1881, and it was therefore submitted that he was not entitled to an unconditional order of discharge. The Registrar adjourned the application generally, with liberty to the Bankrupt to renew it when he had obtained his discharge under a former liquidation.

Electric Lighting in Ottawa.—The Royal Electric Light Company of Canada has received the contract for lighting the entire city of Ottawa for three years, with a prospect of a renewal for five or ten years more. This same company has also received several other large contracts.

The Brush Secondary Battery for Train Lighting.—Writing to *Engineering* from Altoona, Pennsylvania, "A. J. H." says:—"As supplementary to your description of an electrically-lighted train on the London, Brighton, and South Coast Railway, I may mention that the Pennsylvania Railroad Company, after a series of successful experiments, has ordered two trains equipped with Brush secondary batteries and Swan lamps for service between New York and Washington. The necessities of train service here, however, preclude the use of solid trains, and the lighting of each car will be independent. The details have all been worked out in a simple manner and with the view of the probable adoption of the system on a large scale. The Pennsylvania Railroad is one of the best equipped roads in this country, and at present the cars are lighted with gas, compressed and stored in tanks under the cars. The supply only furnishes light for about five hours. The batteries will, however, furnish a much superior light (about two to one in C.P.) for from 12 to 15 hours, amply sufficient for a through run during the longest winter's night on the longest division of the road—Pittsburgh to Jersey City. In the locomotive shops here a small Brush electric motor is used to give motion to the boring bar for reboring cylinders *in situ*."

Dr. Cornelius Herz.—We learn that this gentleman is the recipient of a new distinction from the French Government, he having been nominated Officier de l'Instruction Publique et des Beaux-Arts.

Magnetising the Lodestone. — Professor Antonio Paccinotti, the well-known inventor of the Paccinotti dynamo, has recently made some interesting experiments in magnetising magnetite or magnetic oxide of iron by artificial means, with a view to substituting it for permanent magnets of tempered steel in the construction of dynamo-electric machines. One fact that he has demonstrated is that a piece of natural lodestone placed between the poles of a strong electro-magnet can have its magnetism changed in direction, and a stronger permanent magnetism induced. This induced magnetism may in fact exceed that of tempered steel. M. Paccinotti employed the magnetite of Elbe Island, and an electro-magnet of two coils, each composed of 420 turns of a copper wire 2·5 millimetres in diameter. The cylindrical cores were each 217 millimetres long and 84 millimetres in diameter. The current used was supplied by a little dynamo driven by two men, and giving about 7 ampères. Different lumps of magnetite were magnetised by this apparatus, by placing them between the poles of the electro-magnet, and M. Paccinotti found that crystallised magnetite posssessed no coercitive force and cannot be magnetised in a permanent manner, perhaps because of its purity and crystalline form. Even after being pressed between the poles of a strong electro-magnet, a little octahedric crystal of Tyrolese magnetite and a fragment of magnetite from Traversella did not preserve any trace of permanent magnetism. Granular magnetite, however, which forms the body of natural magnets with armatures, possesses a notable coercitive force. After having been placed between the opposite poles of a strong electro-magnet it preserves in a permanent fashion the artificial magnetism communicated to it, a magnetism which may be much stronger than its natural magnetism, and may even exceed that of tempered steel, weight for weight. Dr. Paccinotti has therefore come to the conclusion that owing to the high cost of good steel magnets, the fine-grained lodestone may be used instead for small magneto-electric machines, worked by hand, always supposing that its magnetism is reinforced by artificial means. Mr. Bosanquet, of St. John's College, Oxford, has made a series of careful observations on the magnetism of hard steel permanent magnets constructed last February, and found it to be subject to a gradual decay or loss of power. In seven months the magnetic moment of a number of these magnets diminished in the ratio of 12 to 11, and Mr. Bosanquet therefore recommends those who employ such magnets to subject them to proper tests.

That Safe Illuminant.—A terrible explosion occurred on the evening of Thursday week, about 11 o'clock, in a dwelling house at Earls Heaton, near Dewsbury, by which one person was killed and two others injured. Early on Thursday morning a traction engine passed the spot with a heavy boiler, and it is supposed that the strain broke the gas main. The gas is supposed then to have percolated into a well, and thence, by means of holes made by vermin, into the kitchen, where it was ignited by the fire. The furniture in the house was smashed, and all the windows blown out, while the gas pipes were twisted all ways.

A gas explosion occurred on Saturday at a house in Barr Street, Birmingham. The place was left by the occupants early in the morning, when some boys entered the premises, and broke the piping connected with the meter. They lighted a fire in the front room, and the place becoming filled with gas, a terrific explosion occurred. The front window was blown into the road, the glass being shattered to pieces, many of the passers-by narrowly escaping injuries. The door was blown away and part of the pavement near the cellar was dislodged. Two of the boys were blown several yards away and were dreadfully burned; they were taken to the Queen's Hospital.

Impure Gas.—The Newcastle and Gateshead Gas Company has been fined £10 for supplying impure gas. The case created great interest in the town.

New Electric Bell.—Within the last few years considerable attention has been paid to the construction of electric bells for domestic and other purposes. The objects in view have been cheapness, efficiency, and compactness. Messrs. Harrison, Cox-Walker & Co. of Darlington, have recently introduced an extremely well-arranged and compact form of bell, which they call their "stud" pattern; the whole of the mechanism, as in the De Redon bell, is arranged under the dome, and the frame which supports the latter and the electro-magnet, &c., is formed of one piece of iron, and is very well designed. These bells are either made for ringing on the ordinary trembler principle, or for working by magneto currents. The firm in question has just completed one of the largest electric bells which has probably yet been made for direct current working purposes. The dome is 18 inches in diameter, and weighs over 60 lbs.; the hammer head weighs ¾ lb., and is fixed on a rod 9 inches long, giving a stroke of from 3 to 4 inches; the pillar supporting the dome is 21 inches high. The coils weigh 7 lbs., without the cores, &c. As the bell is intended for alarm purposes, it is "continuous ringing," but in order that the hammer may get its full swing each time, a special contact arrangement has been designed for making and breaking.

South of England Telephone Company, Limited.—We have received the prospectus of this company, which has been formed under license from the United Telephone Company, Limited. The capital is £400,000 divided into 20,000 preference shares of £5 each, with power of redemption at a premium of 20 per cent. upon the amount paid upon them, and 300,000 ordinary shares of £1 each. The preference shares, which are now offered for subscription, are to be entitled to a preferential and cumulative dividend of 6 per cent. per annum. They are also stated to be entitled to preferential repayment or any final distribution of assets; but do not, it is added, confer upon the holder any vote in general meeting. The ordinary shares will be issued as fully paid up, in accordance with certain agreements with the United Telephone Company mentioned in the prospectus. One fully paid ordinary share will be allotted to subscribers with each preference share. The district in which the company proposes to work is described as the "South of England district, viz., the counties of Northampton, Norfolk, Bedford, Cambridge, Huntingdon, Buckingham, Oxford, Berks, Suffolk, Sussex, and such portion of the counties of Kent, Essex, Surrey, and Hertford as is not in the metropolitan area of the United Telephone Company, which comprises a radius of 12 miles from the General Post Office in London." The arrangements of this company with the United Company are said to be such that, "apart from all the new business that may be expected, the interest upon the capital of the preference shares now proposed to be issued is already assured." Four contracts are mentioned as having been entered into, and it is expressly provided that "subscribers will be deemed to waive the specification in the prospectus of the dates and names of the parties to any other contracts, whether for way-leaves or otherwise."

Portable Electric Bell.—We illustrated in our last issue a convenient form of battery designed by Mr. Applegarth. This gentleman has recently introduced a portable electric bell, which is worked by a single cell of the battery in question. The latter is contained in a small box, on one side of which the bell is fixed. No attempt is made (and wisely so) to seal the battery up, and consequently the apparatus should continue efficient for a lengthened period.

Extradition of Dynamitards.—A Central News telegram, dated St. Petersburg, Tuesday, says:—Communications are passing between the English and Russian Governments respecting the extradition of dynamitards and the protection of submarine cables.

The Society of Telegraph Engineers and Electricians.—The next meeting at 25, Great George Street, Westminster, S.W., will be held on Thursday, February 12th, 1885, at 8 p.m. The following papers will be read:—"On some experiments in electro-typing with a dynamo-electric machine," by Captain H. R. Sankey, R.E.; "The working of railway signals and points by electro-magnets," by Illius A. Timmis, M.Inst. M.E.

On Protection from Electric Currents.—Prof. A. E. Dolbear communicates the following to the *Electrical World*:—In my former article I called attention to the personal factor in the handling of wires carrying strong currents of electricity. Afterward, while thinking about it, it occurred to me to test the effect of covering the hands with oil, &c,, and noting the difference in the resistance thus produced. My resistance from hand to hand while grasping tightly large metallic handles was found to be 12,000 ohms. Then oiling my hands with common machine oil, and again testing with tight grip with both hands, the resistance was found to be 20,000 ohms. With hands dipped in melted paraffin, the same, but the paraffin peels off and leaves large areas bare. Of course it will occur to any one to use gloves when at work in dangerous places, and I think if one would use oiled gloves, he could handle with impunity wires carrying currents with almost any difference of potential, even Sir William Thomson's idea, 80,000 volts. Oftentimes it is impracticable to use gloves when it would be practicable to work with the hands coated with oil or shellac, or some other easily spread substance with high resistance, and thus be protected in otherwise dangerous work.

NEW COMPANY REGISTERED.

South of England Telephone Company, Limited.—Capital £400,000, divided into 20,000 preference shares of £5 each, and 300,000 ordinary shares of £1 each. Objects:—To adopt three agreements, dated respectively, 29th June, 1883, 11th and 16th December, 1884, between the United Telephone Company, Limited, and Mr. Robinson Kendal, chairman of the West Coast of America Telegraph Company, Limited. Signatories (with one preference share each)—Henry Roberts, Dunster House, Mark Lane; W. E. MacAndrew, 3, Courtfield Gardens, Ealing; F. F. Campbell, 26, Devonshire Place, W.; D. O. Bateson, 77, West Cromwell Road, W.; Robinson Kendal, 98, Cannon Street; J. B. Morgan (managing director of the United Telephone Company, Limited), Oxford Court, Cannon Street; F. L. Robinson (secretary), 98, Cannon Street. Directing qualification, 500 ordinary shares. The United Telephone Company is empowered to appoint two directors. The company in general meeting will appoint the remuneration to be paid to the board.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Sir Coutts Lindsay and Company, Limited.—The registered office of this company is at 135, New Bond Street.

Varley Electric Patents Proprietary Company, Limited.—The registered office of this company is at the Mildmay Park Works, Ball's Pond, Islington.

Cordner, Allen and Company, Limited.—The first return of this company, made up to the 20th November, was filed on the 19th ult. The nominal capital is £30,000 in £5 shares. 3,900 shares have been taken up, and £2 10s. per share has been called thereon, the calls paid (including calls paid in advance) amounting to £15,250. Registered office, 20, Bucklersbury.

CITY NOTES, REPORTS, MEETINGS, &c.

The Direct United States Cable Company, Limited.

On Thursday afternoon last the fifteenth ordinary general meeting of this company took place in Cannon Street Hotel, under the presidency of Mr. John Pender, M.P., Chairman of the Board. There was a large attendance.

The Secretary, Mr. J. W. Fuller, having read the notice convening the meeting,

The Chairman said: Before moving the adoption of the report, which I presume you will take as read, I shall, as usual, give you a few figures, which I have no doubt will prove very interesting. The revenue for the half year to the 31st of December last, after deducting out-payments, amounts to £68,824 5s. 2d., and the working expenses and other payments to £18,607 15s., leaving a balance of £50,216 10s. 2d. as the net profit for the half year, making, with £2,786 8s. 7d. brought from the previous half year, a total of 53,002 18s. 9d., which has been appropriated as follows: —An interim dividend of 5s. per share for the 30th of September, £15,177 10s.; an interim dividend of 5s. per share for the 31st of December the same amount; amount set aside to reserve fund, £5,396 15s. 10d.; balance carried forward, £17,251 2s. 11d., making a total of £53,002 18s. 9d. The revenue shows a decrease of about £4,650, as compared with the corresponding period of 1883, no doubt owing to the depression of trade in America, which has so affected our earnings during the last three or four years. The working expenses in London are higher, but the expenses at stations continue to show a reduction as compared with 1883. The expenditure in the last half year has been affected by the alteration of tariffs, involving extra work and outlay in printing and stationery, by the redemption of the debenture loan, and by other causes more or less of a temporary nature. Taken on the whole, however, the working expenses and other payments are less by £3,200 than in the corresponding six months of 1883. The reserve fund has been charged with £73,367 14s. 7d., which, with the addition of our floating capital, has been applied in paying off our debenture loan of £100,000, at the same time reducing our expenditure on capital account, as shown in the balance sheet. The balance of our reserve fund, fully invested, now stands at £300,000. We have realised £50,000 worth of consols in connection with the repayment of the debenture loan, leaving our investments standing at £304,221 4s. 1d., which is considerably less than the present market value. Now, it is my duty to put before you to-day rather a plain and straightforward statement. I wish the directors of the company and the shareholders, at a time like this, to have a thorough understanding one with the other. When I had the pleasure of addressing you at the last half-yearly meeting, I referred very fully to the position of the company, and also to the then impending competition. I stated that Messrs. Bennett and Mackay had laid one cable, and that they were about to lay another, and that when the two cables were completed we should then be face to face with an active competition. There was an idea at one time that the Bennett-Mackay cables would open at the same tariff that we were then working at, namely, 2s. per word. Had they done so I believe it would have been better for them, not only at the present time, but also in the future. They had, however, made so many promises to the public, having stated that their principal object was to give a cheaper telegraphic service, and to break down what they considered to be a monopoly that I presume they felt bound to open with a lower tariff. But did this action arise from a desire to benefit the telegraphing public or from a desire to enrich themselves with what they believed they could see to be a very profitable business? Or was there not a little spice of jealousy in their action against certain parties on the other side of the Atlantic, who had taken a very prominent part in telegraphic communication, not only there but in connection with submarine systems? As to the motive they best know themselves. However, I must tell you that I had more than one conversation with Mr. Bennett, and at one time thought he would have taken my advice, and I had also a considerable amount of discussion on this subject with the late Mr. Garrett who, I may say in passing, was a very shrewd, farseeing and intelligent man, and whose loss is a very serious one to the commercial community of America, as there were few men there who exercised a sounder judgment, and he was successful in developing and placing in the highest possible position one of the leading railways—I mean the Baltimore and Ohio in America —over which he presided. I was quite satisfied myself that additional cables in the Atlantic at that particular time meant simply waste of money, the existing cables being equal to carrying three or four times the amount of traffic upon them, and most of them being duplexed, which placed the cable companies far ahead of the natural growth of traffic. I therefore prepared a statement which, after a discussion of the subject with Mr. Garrett, I handed to him. I also sent a copy of it to Mr. Bennett, and I gave instructions that a copy should be handed to Mr. Mackay: whether it ever reached Mr. Mackay's hands or not I cannot say—I am told it did. However, I believe the facts given in that document decided Mr. Garrett in withdrawing from the cable combination. It is just possible that Messrs. Mackay and Bennett may have imputed my sending this document to them to other motives than those which influenced me. My desire, however, was to prevent them getting into a business which I knew would do no good to them but might do serious injury to a large body of Atlantic telegraph shareholders. But I hope that they will now see that the figures were a fair and straightforward statement. I showed in that document that there was a certain amount earned in the Atlantic at a certain rate, and I gave them figures based upon our extended experience which showed that if the two proposed cables secured their numerical, or cable for cable proportion of the total Atlantic traffic, namely one-fifth, it would only result in a loss of £40,000 per annum, after they had provided for working expenses and a proper reserve fund, but without taking into account a large expenditure for a repairing ship. My facts, however, did not prevent them going on with the venture; and they are now gathering their experience from the working of their cables, and I shall show you presently what the result of that experience will be. And first I would say that the act of opening with a tariff of 1s. 8d. a word and thus forcing a reduction from 2s. was literally—*literally*—throwing away £150,000 per annum, because so far as we can see up to the present moment, also from previous experience the reduction will not generate any increase of messages sufficient to recoup us for that loss, and I doubt very much if we were to take this sum and scatter it over the traffic which has passed whether we should find that it had been of any material benefit to those engaged in telegraphing. But, ladies and gentlemen, it has been a most serious loss, or rather I may say it will be a most serious loss to the companies, to the pioneers who have done so much to promote and maintain an efficient submarine service in the Atlantic; and if continued, I must tell you that it will make a material difference in the dividends which we shall be able to pay you in the future, strictly moderate as they have been in the past. Now we have to consider in what way we can best promote the interests of our shareholders at the present time. Although I am expressing plain facts to you and putting the case fairly and distinctly before you, I do not wish to do so as in any way depriving you of hope for the future, because I think we have the thing pretty much in our own hands to make the future very hopeful indeed. But before we get to that hopeful position I suspect we must go through a little tribulation. Messrs. Bennett and Mackay are of course now gaining experience, but probably before many months have passed, when they come to make out their balance, they will find that the venture which they have gone into is one which from our point of view and from the mode in which accounts are generally kept must show them a most unsatisfactory balance. As shrewd Americans they have been accustomed to high rates of interest on investments, and doubtless they have made investments which, judging from the ordinary rates, would yield a return of probably 6 to 8 per cent., and probably more. They have had to realise some of these, no doubt, to put into a new venture. When they have the opportunity to see this statement—I hope they will not think that I am interfering in their affairs if I put before you what I think will be the working of the new investment as compared with the old—I think I can show you, ladies and gentlemen, something of what the balance-sheet is likely to be. Take the capital at £1,500,000, take the whole earnings of the Atlantic at the present moment at the 1s. 8d. tariff, and it amounts to about £750,000. There are 10 cables—give the Bennett-Mackay cables their full proportion, which will be one-fifth; that will be £150,000; from this must be deducted £50,000 for working expenses, at least £50,000 for reserve, because the rule has been heretofore, it has been kept to as nearly as possible, and it has not been found to be too much, that £50,000 a year should be put aside for reserve for each cable. But allowing that they only put aside £25,000 reserve, though looking to the enormous risk and expense I say again it ought to be £50,000 for each, then we must deduct the expenses of the repairing ship, say £10,000, which is a very low estimate, and £5,000 for duplexing the cables, making up altogether the sum of £115,000, which, deducted from £150,000, leaves £35,000, or 2⅓ per cent. upon their venture, upon their capital of £1,500,000. Now, assuming, as I think we have a perfect right to do, that this one and a half millions of money which they put into this cable venture was previously invested in American securities at 6 to 8 per cent., but for the sake of argument take 6 per cent.—a fair rate for American securities—the result would be that they would have received upon this million and a half £90,000, as against £35,000, a loss of £55,000 as compared with their own interest, or of 3⅔ per cent. upon the cable venture compared with their previous investment. I may say, also, and it may be valuable information for them, that since the Direct cable was opened we have spent in repairs—since the formation of this company—£116,000, although we have been, as I consider, very fortunate, and I think they can scarcely expect to be more so, while the Anglo-American companies have spent a very much larger sum because they have a great many more cables. I think we may reasonably suppose that Messrs. Mackay and Bennett cannot do very much with their new investment, and the question is whether they are likely to continue to work at a rate which gives them such an unsatisfactory return. Bad as it is for them, I am sorry to say that, in some respects, it is worse for us. They had their cables made and laid at a time when they could be made and laid much cheaper than they could be a few years ago. That, of course, ladies and gentlemen, is in their favour; but against that, we have the experience, and the goodwill that comes from having done our work well; and in any competition we shall always get our full share of business. But is it wise on their part, or on ours, to work cables at a rate so low? (Hear, hear.) I have always said that wholesome competition is an advantage up to a certain extent; but beyond that there comes a point when you may be deprived of sufficient income to maintain the service thoroughly efficient. We are approaching that position now. We are not in a position at the present time to put by the reserves we ought

to do; but, fortunately, we have built up a good one in the past. We shall find presently that we have been wise in securing such important reserves as you now possess. The fact that at the present moment—as I wish to draw your attention more particularly to the importance of a reserve fund—there are four cables in the Atlantic which are interrupted, in addition to some shorter sections, show the absolute necessity of a large reserve fund (Hear, hear); and although the prospect of repairing these cables is good, there is always some uncertainty attending the work. There is one thing that is always certain, and that is that the expenses of repairing will be very considerable indeed, and must be provided for. I am sorry to say that amongst those whom I will call speculative dealers in Atlantic cable property, there exists a great desire to stop the further accumulation of reserve with the view of getting some addition to the dividends. I say this is more on the part of speculative holders than permanent holders, who, I hope, will always raise their voice against a policy which will lead to a smaller reserve, and consequently to a lessened security for their investments. (Hear, hear.) Nor are we in a position to maintain the dividend which we have hitherto paid, if this reduced rate is to continue, for we can see no present prospect of any increase in the traffic at these low rates to recoup us for the loss which has been caused by the reduction. I think it may interest you to know that during the last two years the income for Atlantic telegraphy has been: for 1883, £930,000; and for 1884, £880,000; the tariff being 2s. per word during both years. Thus you see there was a decrease in 1884 compared with 1883, due, of course, to the general depression of trade in the States and elsewhere; but we found after a certain point—after a certain amount of money had been expended—that the development was slow, and that it would be influenced more or less by the fluctuations in trade. I have often said, and I repeat it now, that the progress of telegraphy must be certain if the trade of the country grows at all. If it is a "back-going" trade, there is no money to expend, and no inducement to telegraph. We must look forward to a very large rebound in America, and when the rebound comes we shall have a corresponding increase in the use for telegraphy. From our long experience we have pretty well arrived at a rate which we believe to be fair to the sender and fairly remunerative to the shareholders. I have no doubt that by-and-bye we shall revert to that, but in the mean time we have to pass through some tribulation. I think the present rate cannot continue very long; but we are in no great hurry to move, at least until our competitors have gathered a little more experience. I may, however, say without much hesitation that if we cannot agree to establish a rate which shall be satisfactory to the shareholders, we must make such a rate as will make it very bad indeed for all parties concerned; but if we are obliged to go to low rates for a time with the result of your receiving a reduced dividend, the public will eventually have to pay for it, because after this we must establish such a rate as will not only guarantee the money lost, but give us some certainty as to the future. At the present moment our own cable is interrupted but arrangements have been made for its repair, and I hope that with moderate weather we shall soon have it in working order. Although our cable is interrupted, our proportion of the traffic is not interfered with. That is one of the great advantages that accrue from the arrangements entered into with the Anglo Company and the French Company on what we call the "pooling" agreement. I have given you these very plain statements as I think it desirable that you should know, and that the public should know, and that Messrs. Mackay and Bennett in particular should know something of the experience of our board, who have paid a great deal of attention to submarine telegraphy; and I have no doubt that when they have learned the lesson as we have learned it, they will find that it was easier to get into an unremunerative operation than to get out of it. The chairman concluded by moving the adopton of the report and accounts.

Mr. William Ford seconded the motion, and the chairman thereupon invited questions relative to the report.

Mr. Jackson expressed his gratification at hearing that the chairman maintained his loyalty to the principle of a renewal fund. As matters stood he did not look forward with great apprehension to further reduction in the dividend. Four per cent. he considered was very handsome, though 4½ was much handsomer, but people had not much right to complain of either. He further expressed the hope that during this period of depreciated business the board would give their attention to the development of the "social telegram." It was surely quite possible to do something for the general public outside the business men, who worked by code. At all events he hoped that by extra exertions now they would develop their resources and increase the future prosperity of the company.

Mr. Newton suggested the conversion of their £20 share capital into £10 shares. It would have, he thought, considerable advantages and the legal process required to effect the conversion was one of the simplest possible.

The Chairman in dealing with the points raised admitted that there was something to be said, for the development of the "social" telegram; but they must remember that they had had four cables interrupted in the Atlantic, and that involved a large amount of trouble. Referring to the reduced rate for press messages Mr. Pender said that the two prices were 1s. 8d. for ordinary and 5d. for press. They should be very glad to cultivate the press message—but in the meantime they did not, of course, think it worth their while to carry press messages at 5d. a word while they could carry messages at 1s. 8d. With regard to Mr. Newton's proposal it had been considered more than once. But whereas at present their shares stood at £9 10s. they would, after conversion, only stand at £4 10s., and the higher figure looked more respectable. (Laughter, and hear hear.) The position of the company, he might add, was immensely strengthened by their arrangement with the Anglo-American and other companies, as well as by their reserve fund. The reserve was practically worth to each shareholder £5 11s. 6d. per share—that is, that amount was in hand, well invested and secured, in case the cable should break to-morrow. He did not fear much for the future. He expected that Messrs. Bennett and Mackay were actuated by the same principles as ordinary business men; their great idea was to get money out of it, and when the time comes that they find that they cannot reap an adequate return for their cable investment, they cannot benefit themselves without at the same time benefitting the Direct United States Company. (Hear, hear.)

The report was then unanimously adopted.

The customary vote of thanks was heartily accorded on the motion of Mr. T. Stokes, seconded by Mr. Jackson.

In responding on behalf of himself and the board, Mr. Pender expressed the hope that at their next half-yearly meeting he would be able to congratulate the shareholders upon a prospect of recouping themselves for any sum that they had lost during the past period of depression. (Hear, hear.)

The proceedings then terminated.

Anglo-American Brush Electric Light Corporation, Limited.

THE fourth ordinary general meeting of the corporation was held at the Cannon Street Hotel on Wednesday afternoon, when there was a very small attendance of shareholders, rather a contrast to previous meetings, and auguring well, we imagine, for the satisfaction felt by the general body of shareholders in the progress the corporation is making. Lord Thurlow presided.

Mr. E. Garcke, the Secretary, having read the notice convening the meeting,

The Chairman said: Gentlemen—It is a very great pleasure to me and to my colleagues to be able to meet you to-day in what I hope you will all admit are certainly more favourable circumstances than those under which we met last year. The past year undoubtedly has been one of many vicissitudes, and not all of them of a very pleasant nature. Trade generally speaking has certainly not revived to the extent it was anticipated. All commercial interests necessarily suffered more or less from this cause, and it could not have been expected that a new industry like electric lighting could have formed any exception to this rule. Look, for example, at the great railway companies—look at the railway traffic returns for the past twelve months; they certainly do not display a very satisfactory state of things, and they are no bad barometer of the commercial activity of the country. Then look at the joint stock banks and their dividends; they also afford some indication as to the state of affairs, and I would ask you to what are those dividends mainly due? They certainly have not been due to ordinary trading and legitimate business, but to the unusually high figure at which financial accommodation stood during the last few months of the past year. Then look at the depression in the shipping and building trades, and lastly, look at the very low ebb to which British agriculture has come. Well, I think in the face of these adverse circumstances it would have been very unreasonable of us all to have expected manufacturers and salesmen to embark largely in improved methods of lighting their warehouses and their shops, which would have entailed a large outlay on capital account; and, as a matter of fact, they have not done so. They have folded their hands, and are waiting for better days; and the same holds good of what are often, and sometimes, perhaps, rather erroneously termed the leisure class of society, who perhaps not themselves actually engaged in any particular trade, still none the less owe their wealth and means directly or indirectly to some industry or other. Then, I think, if you take all these circumstances into consideration, that the business we have transacted this year has not been altogether of an unsatisfactory nature. We have held our own as well as any of our rivals and competitors, we confront the new year with improved machines, with increased economy in manufacturing, and with a widely extended appreciation, both on the part of the public and of the Government, and especially the Admiralty, for whom we have executed and are executing important orders. I say that we begin the new year, if you consider that, under very favourable auspices; and, in addition, you may remember that our shops are well filled with remunerative work, and that we have a by no means unimportant balance of money at our bankers. Two leading and salient features in our policy in the last year have been the following: the first, the further concentration under one roof of all the operations that are necessary in the construction of a dynamo or lamp, which hitherto were scattered through various buildings several miles apart. Last year we removed the incandescent department from Portpool Lane to Victoria Works; and this year we have followed out the same policy by the removal of the heavy machinery—a great deal of it that is necessary for the construction of the heavy parts of dynamos, and even some of the more minute parts—from Borough Road to Victoria Works. The result of those two removals has naturally been a complete re-organisation of all our machinery, and a very great saving has accrued both in labour and in steam power. It was also necessary to enter into a very careful analysis and re-valuation of all our plant. That has been done by very competent

people, and the result has been to enable us to transfer a great deal of machinery which has now become superfluous to stock account, from which it can be taken to be re-established in works, or disposed of, as favourable opportunities may occur. Then the second salient point in our policy, I maintain, has been the progress we have made in absorbing subsidiary companies. In my mind, there can be no question that the original policy of this corporation in founding subsidiary companies was eminently a sound one, and if the new industry had flourished to anything like the extent that was anticipated, these subsidiary companies would at once have entered upon a lucrative trade and active business. But this dream was not destined to be realised, and, as a matter of fact, the reason for the existence of these subsidiary companies passed away almost as rapidly as it had arisen. Under these circumstances, I maintain that the policy that we are pursuing, of absorbing these companies as opportunities may offer on terms very favourable to them and to ourselves, is at once most generous and most judicious. The report states that we have come to terms with and absorbed the Great Western Brush and the Midland Brush Companies. I will only state that the terms which we have made with those two companies are eminently satisfactory to all parties concerned. The conditions of absorption were not arrived at without lengthy negotiations and careful considerations, and I think I may say not without the making of concessions on both sides. By the terms of the agreements we have acquired, besides cash, very valuable assets and important opportunities of extending our manufacture and our sales. We have also recovered for a sum just under £6,000 our licenses for 28 counties in England and Wales for which you previously received £27,750 in cash; and this £6,000 which we are to pay will be paid in shares. The exact amount of new capital that we shall be called on to create cannot be quite accurately stated, but there can be no doubt that the total will be considerably short of the maximum that stands in the report. Then on this new capital of course we shall have to look to pay a dividend; but in a good dividend year it will be an additional charge which will not be felt, and in a bad dividend year it certainly will be unimportant. There is one paragraph in the report to which I desire to call your attention; it is a paragraph second to none in importance. I refer to the paragraph which gives details of the steps we have taken and are taking to procure a complete revision of the Electric Lighting Act of 1882. To ask a Government that has passed an Act to repeal it is an undertaking of considerable magnitude, but I can say that I am sanguine of success, as we have public opinion on our side. We have been met very frankly by the Edison and Swan Company, by Mr. Hammond, by Mr. Crompton, and by all the leading men connected with electric lighting; they have set aside any differences they may have had with us, and have made common cause to obtain a removal of the fetters of 1882. That Act of 1882 must, I think, be cautiously approached. There is no doubt in my mind whatever that the provisions it contains have acted most prejudicially and most unfairly on this new industry. At the same time I am one of those that think and believe that when that Act was passed its authors really were anxious to encourage the new industry; but none the less am I one of those who hold that on that occasion Parliament mistook its duty, which certainly was to have fostered by every means in its power and not to have throttled a new discovery which was destined to confer such great benefits on mankind; and for all that I think our best chance of arriving at a satisfactory solution is to argue the question with calmness and without passion. You must remember the circumstances under which the Act of 1882 was passed; you must remember that the science was in its infancy, that the only thing that was patent to the public and to the Legislature was the rash gambling spirit that prevailed at the time, and which the Legislature naturally deemed it its duty to curb and discourage to the utmost extent in its power. On looking back to that time I cannot help feeling that the attempt that was made, although it was almost superhuman, to frame an Act that should not require amendment, and that should be adaptable to the advancement of science, as other improvements should be made, has failed, and it cannot be wondered at. I will go further, and I think, as regards those authors, that so far from giving rise to the recriminations and the aspersions that have been cast upon them, they in due time will take their places amidst those pioneers of the legislation of the future of whom the British Parliament has produced so many examples. Well, gentlemen, strong in our convictions, we have approached Mr. Chamberlain, who received us with an evident desire to lend an unprejudiced ear to what we had to say. We had the good fortune to get our case stated by Sir Frederick Bramwell, than whom no one can state a case better, and finally we were requested by Mr. Chamberlain to draft clauses of amendment for the consideration of the Board of Trade. We are still engaged in that task, with the assistance of Sir Frederick Bramwell and many other distinguished men, and I for one look forward with confidence to a recognition of the justice of our demand. I must say a few words on our financial condition. The year's working shows a gross manufacturing profit of £23,000. Of that sum £16,723 are absolutely on manufacturing account, and I desire to say that this figure has been made the subject of a careful scrutiny both by ourselves at this board and by our accountants and our auditors, and it may be relied upon as substantially correct. The other figure of £6,000 which appears in the account as sundry profits other than gross profits on trading, that figure represents items of what perhaps some companies might consider an unusual character, but they are items fairly belonging to revenue account, and one of my reasons for saying so, and insisting on the point, is that they are items which, in a concern like this, will recur, and must in the nature of things recur, year after year, to a greater or less extent; they belong distinctly to revenue and not to capital. That gross total of £23,000 of profits would have been larger by many thousands of pounds had it not been for the unfortunate falling off in orders in the summer months of 1884. Our nett profit, after deducting the standing charges, &c., stand at £5,743. This would have been larger by £2,000 had it not been for the proverbial uncertainty of the law, which was strikingly exemplified in the Muir law suit, a case very unfortunate to us all, but for which the present management is not responsible. No item of that kind can enter into the accounts of 1885 and eat into the profits of the year, as all the law charges of 1884 have been valued and provided for, and we stand at this table not only free of all litigation, but, I believe, without any chance of repeal of anything which has been given in our favour; so that whatever litigation there may be in store for us in the year 1885 will be honestly incurred in that year. The first duty in appropriating a financial margin is, as you know, to clear off the adverse balance, if you unfortunately have one, of the year before, and our accountants have done so in this balance-sheet. The sum, therefore, which we are called upon to-day to appropriate is £4,127. Now this sum would be sufficient to enable you to declare a dividend at the rate of 2½ per cent. on the paid up capital for the past 12 months if you desired to do so, but that is not a course which we can recommend for adoption. We advocate the course which is sketched in the appropriation account which is attached to the balance-sheet; it is to write off £1,500 on patents account to write off £1,000 for the whole of the licenses recovered, and to carry forward a balance of £1,627 to our credit for the ensuing year. We feel sure, gentlemen, that this is the course which will give confidence to all, and which will be acceptable to the great body of shareholders, and we also feel that it is the course that will be most consistent with the real interests of the corporation. At the same time I do not want you to lose sight of the fact, and I think it is one we may congratulate you upon, that we have turned the corner and returned to the position of a dividend-earning corporation. I will only add that I hope you will approve the recommendation we make to you to nominate Mr. Joseph Bevan Braithwaite as a director of this corporation. You are aware of his antecedents and his title to the position; you know that he was chairman of the Great Western Company, which we have absorbed, and you know the great interest that he has always taken in electric lighting, and the great talent he brings to bear on all business he turns his hand to. We believe, also, that he possesses to quite an unusual extent the confidence of a very large section of the shareholders, and we also feel that, as regards ourselves, it cannot fail to be a very great advantage to us to have the benefit of his great financial knowledge in dealing with the large money questions which so constantly come before us. Having eulogised the staff of the corporation, the chairman said: I have now to add one little fact which may serve as a straw to indicate the way the wind blows. A little bit of paper has been put into my hand since I entered this room, containing intelligence which I think you will admit is of a very encouraging character. One of the most successful of the gas companies—an English company, but I am not at liberty to state the name of it—is asking for powers to raise £300,000 to be used in electric lighting. I have the honour now to propose that the report of the directors and statement of accounts for the year to the 31st December, 1884, now presented to the shareholders, be received and adopted.

Mr. J. S. Sellon seconded the motion, remarking that he would wish to emphasize with all earnestness what had been foreshadowed, viz., that with the advance of electric lighting, which was inevitable now that its advantages and practicability were realised, and with the prospect that the ever-to-be-condemned Electric Lighting Act of 1882 would be remodelled on lines of intelligence and justice, their property would stand out well in the foreground as embodying the three great essentials of success—a good and well-proved system, the highest class of workmanship, and a most excellent executive staff.

Mr. Wm. Abbot remarked upon the enormous sum which had been expended to earn the small profit, and said unless the board could see some way of reducing the expenses at the end of 1885 the company would be in the same position as at the end of 1884. As a rule he abstained from criticising the question of directors' fees, but in this case he could not disguise from himself the fact that the sum of £1,500 for directors fees was a monstrous charge upon such a small result. The salaries, he also thought, were exorbitant. He would like to hear whether the item of £268, which was small in proportion to other charges, for probationary and public installations was likely to disappear from the balance sheet in future.

Mr. Reynolds spoke upon an increase of expenditure on the item of patents, and expressed a hope that the board had not expended anything in the purchase of further patents.

Mr. Hall also referred to the large amount drawn by the directors compared with the results.

Mr. Pigott, who said he was an original member of the corporation, and one of the largest shareholders, advised the shareholders not to do anything from false parsimony which would impair the efficiency of their board of directors.

The Chairman, in replying to the various points raised, said he was very grateful that the shareholders had spoken so freely. But he could not help thinking that on reflection it would be seen that Mr. Abbot had not dealt with their figures in a very fair spirit.

The total charges of the year 1884 were £14,693 as against £26,533 in the previous year, a diminution of 45 per cent. in one year. He was afraid they could not expect a continuation of such results, but he could assure them that the directors would not relax their efforts at economy. There was a considerable saving in gas and water, notwithstanding that they were doing a great deal more work than last year. They were expecting to effect a reduction also in rent; that was one advantage they looked to derive from the concentration of the works. As to salaries, they must remember that the position of a manufacturing corporation like theirs was very remarkable, and they had to keep not only abreast, but, if possible, in front of all competitors; to do this they had to get hold of the best men they could find, and they had to pay them the salaries at which they would come. He did not think if the salary list were inspected that it would be found excessive; but, although more men had been employed, and 120 per cent. more work done, there had been a reduction to the extent of 17 per cent. in this respect in the year. In stationery and printing there was a saving of 28 per cent., in travelling expenses 80 per cent., and in carriage and freight 65 per cent. He thought these figures would speak for themselves. A fear had been expressed that money had been spent in purchasing more patents; that was not the case—they had not acquired outside the works any more patent property during the year. The increase was for the cost of developments and improvements made in their own works, in connection principally with the new armature which was of such enormous advantage to them, and which had achieved such excellent results, and which he thought would very soon be recognised as almost as efficient as an armature could possibly be made. As regards an interim dividend, he could only say he should be the first to hail it, and if things went on well there was no reason why there should not be one. With regard to the expenses in connection with the Muir case, he might say that the eminent firm of solicitors who had advised them had declined to take any remuneration for their own costs. On the question of directors' fees, he thought the labourer was worthy of his hire and he knew from his own experience during the past 18 months that the position of a director on that board was not a sinecure. They had to undertake very great responsibility and very great liability, and, he maintained, to get the services of men to whom they could entrust those duties and to expect that those duties would be well performed, they ought to afford some kind of remuneration before they could look with confidence to the result. If they were not satisfied with the present directors that was quite a different thing; then he would say remove them and get others; but unless they were prepared to take that course he could not see that the rate of remuneration was at all exorbitant.

The motion for the adoption of the report was then put and carried unanimously.

Upon the motion of Mr. Brooksbank, the retiring directors, Mr. Gibbs and Mr. Courtenay, were re-elected.

The Chairman then moved the election of Mr. J. B. Braithwaite, jun., to the board.

Mr. F. W. Reynolds seconded, and the motion was carried unanimously.

The auditors, Messrs. Cooper Bros. and Co., were re-elected, and a vote of thanks to the chairman and directors, upon the motion of Mr. Abbott, having been carried, the meeting terminated.

South African Brush Electric Light Company, Limited.

A GENERAL meeting of this company was held on Wednesday at the City Terminus Hotel, Cannon Street, for the purpose of receiving the audited balance-sheet to the company, made up to the 28th January, 1885. Lieut.-Col. Coxon presided.

The Secretary (Mr. Thomas J. Seel) having read the notice convening the meeting,

The Chairman said: It has not been thought necessary to have the accounts printed. It was desirable to bring them up to the latest possible date, and of course these are the audited accounts here and any gentleman may examine them. The cream of this document is in these few items that I shall read out to you. We have in assets—at the Bank £10,683 4s. 2d. We have a bill due about June 13, 1885, £1,500, and an outstanding account with the Town Council at Kimberley—an undisputed account of £1,680, which we have instructed our representative to proceed at once for the recovery of. It is carrying interest at 12 per cent., but we expect daily to hear that it is paid; and the small item of sundries (£235) brings the gross assets to £14,098 4s. 2d. The debts, including an estimate of the expenses up to January 28, are £495 4s. The expenses of liquidation, £13,603 19s. 1d., will run to about 14s. a share. I have nothing more to add upon the matter. We have come to the end of our tether, and I will propose the passing of the accounts.

Mr. J. W. Anderson seconded.

A Shareholder wanted to know the reason why the Kimberley Town Council did not pay up.

The Chairman said it was a way they had. They never paid anything without being threatened.

A Shareholder asked what was the position of the concession the Chairman had spoke of having sold.

The Chairman said the proceeds of the sales were £6,285 2s. 5d. That left them the patents for the whole of the run of the Cape, and that was an asset now in their hands to be dealt with by the shareholders. It would remain in the hands of the liquidator. It was a complete document in the form of a license with a slight modification upon the original license which they had with the Brush Company for the use of the patents for the whole of the Cape of Good Hope, with the exception of Kimberley or Cape Town.

The accounts were then passed, whereupon the meeting resolved itself into an extraordinary general meeting, and the Chairman moved "That the company be wound up voluntarily under the provisions of the Companies' Acts."

Mr. Thomas Dickson seconded, and the resolution was carried unanimously.

The Chairman: With regard to the remaining business, the appointment of a liquidator, although we were not absolutely unanimous on the board, the majority of the directors have passed a resoultion that I should propose to you that our secretary, Mr. Seel, should be sole liquidator. I recommend "that Mr. Seel, the secretary of the company, be appointed as sole liquidator with a fee of 100 guineas, and that there be conferred on him all the power which can be conferred upon a liquidator under the provisions of the Companies' Acts."

Mr. Porter Rhodes seconded.

A Shareholder asked if that would be the entire expenses of the liquidation.

The Chairman said there would be the solicitor's costs and the cost of correspondence.

Mr. Dickson said he was the director who had dissented from Mr. Seel being the liquidator. He did not want to put the money he had invested in the company in the hands of a gentleman who was not a shareholder, and who did not represent the interests of the company so closely as a shareholder would. He thought that Mr. Seel should have another gentleman associated with him as liquidator.

A Shareholder asked if the expense of having two liquidators would be greater than one?

The Chairman said that it naturally would be greater. He thought that the directors had done everything for the best in recommending a gentleman as sole liquidator who had the company's business at his fingers' ends. It might be as well to state that they were not clear entirely of the parent company in this respect. They had assigned to Kimberley and Cape Town patents, but they had, in assigning these patents, the responsibility still attaching to them.

After a short discussion the resolution was carried unanimously.

Mr. Seel thanked the shareholders and said it would be his duty to distribute the assets as quickly as he could. He did not anticipate any difficulty with the Brush Company, as they had already intimated to him that they would be ready to take direct contracts with Kimberley and Cape Town.

The proceedings terminated with a vote of thanks to the Chairman.

The National Telephone Company, Limited.—At a meeting of the directors held on Wednesday it was resolved to declare a dividend for the six months ending December 31st last, at the rate of 6 per cent. per annum on the preference shares, and at the rate of 2 per cent. (as against 1 per cent. for corresponding period last year) on the ordinary shares, and that the balance of £5,783 should be carried forward, as against £3,942 last year. The unaccrued revenue carried forward to the credit of next account amounts to £29,956, as against £24,146 last year.

The Submarine Telegraph Company, Limited.—The accounts for the half year ended December 31 last, show a balance, subject to audit, which enables the directors, after adding 15 per cent. of the gross receipts to the reserve fund, to recommend a dividend at the rate of 14 per cent. per annum.

Great Northern Telegraph Company, Limited.—Debentures of 1882 (Series B).—The numbers are published of 100 Debentures drawn in Copenhagen on the 24th instant for repayment on the 2nd of March next, at the office of Messrs. C. I. Hambro & Son, 70, Old Broad Street, E.C.

Irwell India Rubber and Gutta Percha Works Company, Limited.—A petition for winding up this company is to be heard before Vice-Chancellor Bacon on the 14th inst.

Oriental Telephone Company, Limited.—A call of 1s. per share has been made payable on March 10th.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The number of messages passing over the lines of this company during the month of January was 3,556, estimated to produce £3,000, against 3,291 messages, producing £3,009 in the corresponding month of last year. The receipts for the month of October, estimated at £2,200, realised £2,230.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending January 30th were £2,916, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of January were £1,770, against £2,072 in the corresponding period of last year.

The Eastern Extension, Australasia and China Telegraph Company, Limited. The receipts for January, including Government subsidies, amounted to £44,144 and to £41,129 for the corresponding period of 1884, an increase of £3,015.

The Great Northern Telegraph Company. The receipts for January, 1885, £20,800; for the corresponding month of 1884, £19,360; and for 1883, £18,400.

The Eastern Telegraph Company. The receipts for January amounted to £57,249 and to £55,503 in the corresponding period of 1884, an increase of £1,746.

NEW PATENTS—1885.

1209. "Locking electric conductors." G. BARKER. (Communicated by J. W. Tringham.) Dated January 28. (*Complete.*)

1212. "System of induction current generator for long cable telegraphy." S. Ross. Dated January 28.

1220. "Dynamo-electric machines." W. H. AKESTER, R. MITCHELL, R. R. KELLY. Dated January 28.

1221. "Secondary batteries." W. H. AKESTER, R. MITCHELL, R. R. KELLY. Dated January 28.

1234. "Electrical recording apparatus for use on railways." J. ENRIGHT. Dated January 28.

1281. "Electro-motors." D. T. PIOT. Dated January 29.

1288. "Establishing electric connection between surfaces in relative motion, applicable to the collectors of dynamo machines." G. FORBES. Dated January 29.

1320. "Telephone transmitters." C. MOSELEY. Dated January 30. (*Complete.*)

1423. "Electric arc lamps" J. SWINBURNE. Dated February 2.

1435. "Holders or attachments for incandescence or glow electric lamps." H. COURT. Dated February 2.

1439. "Electric clocks." A. W. RIXEN, R. THEILER. Dated February 2. (*Complete.*)

1444. "Cable telegraphing at great distances and apparatus therefor." P. JENSEN. (Communicated by E. Baron von Taund-Szyll.) Dated February 2.

1482. "Method of keeping cool dynamo-electric and magneto-electric machines during the working of same." A. LUMLEY. Dated February 3.

1505. "Electric batteries." W. R. LAKE. (Communicated by H. L. Brevoort and J. L. Roberts.) Dated February 3.

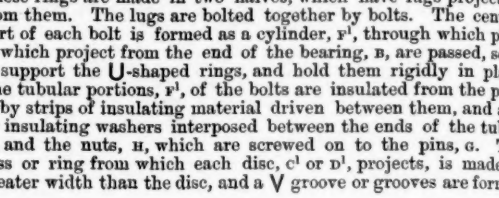
ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1884.

2535. "A new or improved telephone holder." G. W. ERRINGTON and F. CAWS. Dated February 1. 6d. Consists of an elastic or spring holder which may be of various forms, but in all of which the telephone is held in position against the head by means of the recoil or rebound of the material forming the holder after it has been sprung, pulled, stretched or bent out of its normal position.

2750. "Improvements in the construction and working appliances of galvanic batteries." S. H. EMMENS and THE UNITED PATENTS CORPORATION, Limited. Dated February 5. 4d. Each cell of the batteries is preferably of a rectangular form, and may be made separately or as a compartment of a vessel divided by partitions into two or more cells. In each cell they place one or more porous pots of a form conformable to that of the cell, and resting either on the bottom of the cell or on one or more chocks, so as to admit of free circulation of the outer fluid. The porous pots are covered by lids with sides sufficiently deep to form a water seal in the outer fluid when the cell is charged, and thus they prevent the escape of noxious fumes when a fume-emitting-dehydrogenising fluid is used in the porous pots. The inventors furthermore provide the lids with discharge tubes or nozzles for causing the fumes to pass off in any required direction. The tops of the lids are extended lengthwise so as to rest in notches made in the sides of the containing cells. The negative electrodes consist of plates of carbon or other suitable material, and they or their poles are carried through the lids. The positive electrodes consist of plates of zinc or other suitable material, and are provided with hooks or clips which hang on strips of metal affixed to the sides of the lids, and in electrical connection with each other. The positive terminals are made in the shape of small cups, which are partly filled with mercury or amalgam, and the connections between the different cells of a battery are effected by means of spring clips of brass attached to copper strips carrying a projecting stud at the other end, the clips being pressed down over the hooks of the positive electrodes, and the stud dipping into the cups of the positive terminals. Excellent contact is thus ensured, and can be made or broken without the trouble of screwing and unscrewing nuts, as is the case with cells of ordinary construction.

4655. "New or improved suspensions for electrical incandescent lamps." Sir WILLIAM THOMSON. Dated March 10. 6d. When the lamp is one having its electrodes terminating outside the glass in platinum or other metallic hooks or rings, the inventor supports it on two platinum hooks soldered to the ends of two flexible springs, preferably of flat watch spring, set so as to keep the hooks at a considerable distance apart when they are free, and so that it is necessary to pull them together through a considerable range in order to hook the two lamp rings upon them. Thus by a very moderate but approximately constant force a good electrical connection is permanently maintained between the lamp rings and the bearing springs.

5335. "Improvements in dynamo electrical machines." Sir WILLIAM THOMSON and S. Z. DE FERRANTI. Dated March 22. 6d. Relates to a collector for alternating current machines. In the fig., A is one end of the hollow axis of the dynamo machine. B is part of the bearing in which it revolves. C and D are two concentric insulated conductors carried through the centre of the axis, A. On the end of the conductor, C, is secured a disc, C^1, and on the end of the conductor, D, a disc, D^1. E, E, are rings of a U form in cross section encircling the circumference of the disc. These rings are made in two halves, which have lugs projecting from them. The lugs are bolted together by bolts. The central part of each bolt is formed as a cylinder, F^1, through which pins, G, which project from the end of the bearing, B, are passed, so as to support the U-shaped rings, and hold them rigidly in place. The tubular portions, F^1, of the bolts are insulated from the pins, G, by strips of insulating material driven between them, and also by insulating washers interposed between the ends of the tubes, F^1, and the nuts, H, which are screwed on to the pins, G. The boss or ring from which each disc, C^1 or D^1, projects, is made of greater width than the disc, and a V groove or grooves are formed



around the circumference of these projecting bosses as shown, corresponding grooves being formed in the troughs, E. These grooves tend to prevent any escape of mercury from the trough, more especially at the times when the speed of rotation of the axis is being reduced or arrested. The lower part of each trough is widened out at its mouth. so that when the axis ceases to revolve the mercury, which previously was being distributed all around the circumference of the ring trough may collect in the enlargement of reservoir so formed—or in place of this the pipe might as before stated be, if preferred, led away to a separate reservoir. I, I, are washers of insulating material interposed between the discs, C^1, D^1. J is a metallic distance piece between the washers. C^2, D^2, are nuts screwed on to the ends of the conductors, C and D. K are conducting bars, by which the rings, E, are put into electrical communication with insulated terminal blocks; they are connected to lugs which extend from the cylindrical portion, F^1, of one of the bolts.

6068. Improvements in secondary batteries." E. JONES. Dated April 7. 6d. In the improved secondary battery, each electrode in a pair is a counterpart of the other, and each is formed entirely of a metallic lead so disposed as to present a very large extent of surface to the action of the excitiug fluid in the battery. This large surface of metallic lead is obtained by forming the electrode with a number of strips, ribbons, or wires of metallic lead, arranged in rows and integrally united with a base or wall of similar material, and preferably at right angles thereto. The two electrodes for every pair have their projecting strips, ribbons, or wires, so arranged that when in their proper relative position, the bases or walls will be opposite and parallel the one with the other, and the rows of strips, ribbons, or wires projecting from one plate or base will interlock or alternate with those on the other plate or base, and will leave room for the insertion between them of insulating plates of glass or other suitable material.

CORRESPONDENCE.

Edison's Patent.

In the specifications of Edison's patent will be found the following :—

"I sometimes arrange the battery in connection with the transmitting instrument, as shown in fig. 10.

"*h* is the resonant chamber, at the end of which is

the diaphragm 10, and at each side of this diaphragm there are springs, c^2, c^3, having points made of compressed plumbago mixed perfectly with gum rubber, but any substance not liable to rapid decomposition, or the elastic or fibrous tension regulator aforesaid may be used.

"As the tension regulator of fiber or of plumbago decreases and increases its resistance enormously under slight changes of pressure, it follows that the strength of the electric waves will be in proportion as the speaker's voice is strong or weak."

The apparatus above described is the combination of a resonant chamber and diaphragm with a tension regulator. In the original patent this arrangement was the subject of the 13th claim.

"The combination with the diaphragm of a resonant case, of circuit connections at both sides of the diaphragm, and a battery substantially as shown in fig. 10."

This claim was disclaimed by the first disclaimer, filed 10th February, 1880, and therefore the combination is free to the public, to be used with any modifications of resonant case, of diaphragm, or of tension regulator. There was a combination of three things claimed, now specifically disclaimed, and in the patent as disclaimed on August 17th, 1882, there is only one claim, and that is for "the combination with a diaphragm or tympan, with tension regulators, substantially as before described;" and this claim was also in the original patent, which proves that the intention of the inventor was to claim two distinct apparatus—namely, one with three things, resonant case, diaphragm, and tension regulator; and another with only two things—diaphragm and tension regulator. Now, as the claim for the combination of the three things has been disclaimed, surely the claim for the two things cannot embrace the three things.

If a patentee claims a combination of A, B, and C, and also claims a combination of B and C, and subsequently disclaims the combination of A, B, and C, retaining the combination of B and C, surely this combination cannot cover the former one.

Edison describes his machine, and says:—"There is my diaphragm, there is my tension regulator; the combination of two things is what I claim." He could not possibly say, "That is a claim for three things."

Although Edison has abandoned the claim for the combination of a resonant case with a diaphragm and tension regulator, yet in the description of his instruments he always has his diaphragm and tension regulator in a resonant case, as shown by the following sentences to be found on page 3, lines 12, 13, 14, 15, 16, and 17 of the third disclaimer, filed August 17th, 1882:—

"In my present invention I make use of the vibrations given to a diaphragm or tympan by speaking into a resonant case to produce a rise and fall of electrical tension upon the line . . . .

"The transmitting instrument in a complete form is represented in section in fig. 1.

"Referring to fig. 1, the resonant tube or box, *a*, is of a size and shape adapted to being spoken into the the same, having an opening at one end or side, and a diaphragm or diaphragms, *b*, against which the sound waves from the human voice act."

In all the drawings in the patent exhibiting Edison's transmitter there is not one that has not a resonant case, and I venture to assert that an Edison transmitter, or Blake-Edison transmitter, has never been made without a resonant case; yet Edison disclaims the resonant case combination. In construing claims, one must construe them not as enlarging the operation of the description, but rather as disclaiming everything which is not claimed.

In this case Edison has disclaimed the combination of the three things, and surely the remaining solitary claim for two things cannot embrace the three things.

It seems, then, that the use of a resonant case with a diaphragm and tension regulator is free to the public.

Das Telephon.

January 31*st*, 1885.

The Transmission of Articulate Speech by Reversed Intermittent Currents.

In my letter published in the REVIEW of 3rd January I sent you a statement of the successful results I had obtained with an intermittent current, and the manner of using them.

I now have the pleasure of sending you briefly the results of a series of experiments which I have made with a reversed intermittent current, but for the present I forbear to describe the means employed by me.

Using alternating positive and negative currents with an absolute break between each pulsation, with two cells, medium size Leclanché, having a resistance of 962 ohms in the metallic circuit, with a receiver having a permanent magnet with a coil of 120·5 ohms, crossbar armature, and wooden disc. Speech was transmitted with perfect articulation and with greater intensity of sound than when using the same instruments in the ordinary way, that is, with what Bell calls undulatory currents. That the sounds should be more intense I was not surprised, because it is well known that currents of opposite polarity passing through a coil on a magnet will produce much greater variations of the magnetic force than will a current of one kind only.

I made other experiments with alternate positive and negative currents, but instead of having an absolute break of current I arranged that the currents should overlap one another—such a current as Bell terms a reversed pulsatory current. I find, however, that the sound was much less than the former way, while the articulation was equally distinct.

I repeated these experiments a great number of times with similar results, and I also made experiments with the usual current with the same instrument, and the intensity of the sound was very much less than with the reversed intermittent current, and less than with the reversed pulsatory current.

W. C. Barney.

February 2*nd*, 1885.

The Mechanical Testing of Wires.

I take the liberty of asking you to give me in the next issue the names of some firm or firms which furnish apparatus for mechanical testing of telegraph and telephone wire.

Hoping you will excuse my troubling you,

"Subscriber."

Stockholm, *January* 28*th*, 1885.

[We should think that Messrs. Johnson and Phillips could meet our correspondent's requirements.—EDS. ELEC. REV.).

Primary Batteries for Electric Lighting.

I shall esteem it a favour if you will kindly inform me through the medium of your next issue the name, and where I could obtain a good reliable battery for the above. The work it is wanted for would be to light, six 10 C.P. lamps of 20 volts, for about six hours at a time, two or three times a week. One preferred that could be used two or three times without fresh charging.

M. P.

London, *February* 2*nd*.

[We should think that for a small installation, such as "M. P." quotes, the Lalande-Chaperon battery would be most suitable, for, although its E.M.F. is very low—less than 1 volt per cell—its constancy is, we believe, to be relied upon, at least for so long as our correspondent requires—see "Notes" columns.—EDS. ELEC. REV.]

The Validity of the Morgan Brown (Bell) Patent—The Membrane Diaphragm, &c.

With reference to the letter of your correspondent "Das Telephon" in your issue of the 31st ult.

The reply to your correspondent's question, in my opinion, very much depends upon the construction which the United Telephone Company seek to put upon the words he quotes. If they seek to still claim

any membrane except goldbeaters' skin, and this is sustained, obviously their patent is bad. I cannot see, however, that the patent claims any membrane. It would be impossible for the patent to disclaim one membrane and still claim all others. It seems to me in considering this question that it should be borne in mind that Bell stood in the same position as any other inventor, and that to have a valid patent he must add to our stock of knowledge. Let us banish from our minds everything which the patent contains. Prior to December 9th, 1876, we knew of Reis's electro-magnet receiver, the "English Mechanic" receiver, the receiver described and shown in Bell's American specification, and the "Glasgow" receiver. What is the effect of this? Why that Bell stood in precisely the same position as would any other inventor, and to have a valid patent, he must start from the same point as anyone else, and improve the apparatus by such means as would be sufficient to secure a valid patent for any other inventor. It is not a question of looking *first* at *his* patent, then at what we previously knew (both as regards the apparatus and the material of which it was formed), and then giving to him everything else. No; he must add to our stock of knowledge, by making a patentable improvement. I respectfully submit that Bell did so by simplifying the apparatus—by unifying the parts; but it is simple nonsense for the United Telephone Company to attempt to claim any more.

Of course, in any action that comes before the Courts, the point raised by "Das Telephon" might be put, and he is entitled to the thanks of those of your readers who are interested in the question.

Speaking of the validity of the patent, may I urge the following reason why the patent is bad, and ask for the opinion of Mr. Strangways, or others of your readers having a knowledge of the patent law? The *provisional* specification although accompanied by drawings, and containing a very full description, neither shows, mentions or describes a soft iron pole piece for the magnet; and yet it is claimed as an essential and specific part of the combination claimed by claim 8. Does the patent law permit this? I know that *without* this claim the patent would have prevented anyone else using this particular combination; but, in my opinion, the claim is too specific, and in that respect is fatal to the validity of the patent. It has claimed not an instrument broadly, but a specific combination, one part of which is not once mentioned in the provisional specification. We know that a soft iron pole piece is very advantageous, and is much better than the permanent magnet itself forming the core for the coil. What right, therefore, had Bell to claim this improvement when it is not mentioned in his provisional specification?

With regard to Major Barney's very interesting experiment with reference to the undulatory current theory, described in your issue of the 3rd ult., he there stated that the makes and breaks in the continuity of the circuit were at the rate of 1,000 *words* per minute. Taking one paragraph of his letter I find each each word averages five letters, and I believe the Morse code averages about 3·076 pulsations of current per letter. This would give us about 15,000 breaks in the continuity of the circuit per minute. This, I understand, was taking place in the primary circuit, and yet the articulation was in no way interfered with. May I ask Major Barney if, when the circuit was being thus rapidly opened and closed, there was any sound or noise to be heard in the receiver, due to this make and break? If not, how does he account for the current not actuating his receiver? I beg to assure Major Barney that I do not ask the question with the object of casting any doubt upon the accuracy of the experiment, because I think with him, that with the hard carbon contact there is not an undulatory current. I am afraid, however, that before we shall be able to convince *all* those tenacious advocates of the undulatory theory, a *very* practical and visible proof will be necessary. Would it be possible to move a chemically prepared paper at a sufficient speed, so that, inserted in the secondary circuit, the current could mark whether it (the current) was continuous or not? Of course it would serve the same purpose in the primary circuit; indeed, it would probably be more conclusive if fixed there.

F. T. H.

Derby, *February 2nd*, 1885.

Scientific Secondary Batteries.

Mr. Preece, in his speech at the National Conference of Electricians, Philadelphia, as reported in your last issue, made the following statement:—"Mr. Tribe (with others) has approached the matter of secondary batteries in a truly scientific spirit, and investigated it most carefully. The result is that Mr. Tribe has brought out a form of secondary cell, although it is not yet in the market, *that is a great improvement upon anything that has ever been brought out before.* These persons have been working silently on the subject, and have gone back to Planté's original work, and have followed Planté's original method."

As I have amused myself a little with secondary batteries, such a statement naturally induced me to look up Mr. Tribe's specifications, which appear to be two in number.

No. 1, April 21st, 1882.—*Claim.*—The employment of a negative plate or element composed or consisting of peroxide of lead, substantially as described.

Abbreviated Description.—A negative plate, consisting of peroxide of lead in a solidified condition, or in a compressed condition, or in a non-solidified or non-compressed condition, or in any other suitable condition, contained in a perforated or porous vessel not being a conductor, one side of such vessel being completed by the employment of a suitable conductor projecting out of the liquid, and insulated on those parts which are in the liquid and not in contact with the oxides of lead, or the frame may be entirely of any suitable conducting substance, or entirely of a non-conducting substance, with a conductor passing round or partly round it.

No. 2, November 24th, 1882.—*Claim.*—A positive element, consisting of lead in combination with a frame of non-conducting material, and a conductor of lead constructed as described.

Abbreviated Description.—A rectangular frame with three sides of any non-conducting substance, the fourth side being completed with a metallic conductor, preferably lead, or the frame can be made entirely of lead, or entirely of a non-conducting substance, with a suitable conductor round or partly round it; into or upon such form of frames peroxide of lead or minium, or an admixture of these with mon-oxide or sulphate of lead may be placed, after being brought to the necessary consistency, or a core of the compressed oxides or sulphate of lead may be fitted into the frame.

I confess to being disappointed at finding myself quite unable to understand in what consists "the great improvement over everything which has gone before," vouched for by an authority so disinterested and consistent, as Mr. Preece, from his position, of course must be; and from what I know of the work done by Mr. Planté, I fear that he will scarcely like to have the principles of such forms (so far as I can make them out) fathered upon him, even after the long and silent working, and despite their highly novel and scientific character.

I have not the honour of being acquainted with, nor do I know that I have seen Mr. Preece or Mr. Tribe; but I venture to ask one or other of them to kindly explain to your readers (many of whom may, like me, be in the dark) what these claims mean, in what consists the science or novelty, and how plates so constructed are worked.

As secondary batteries, up to the present time, do not seem to have made the progress anticipated, it will also be interesting to many of us to know how we can avail ourselves of the "greatest improvements yet made."

My apology for asking is that I am one of the

"Unscientific."

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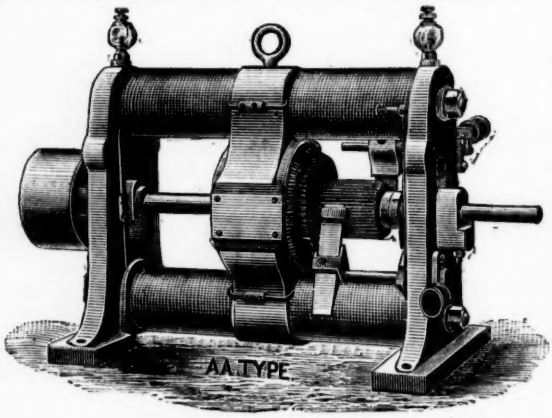

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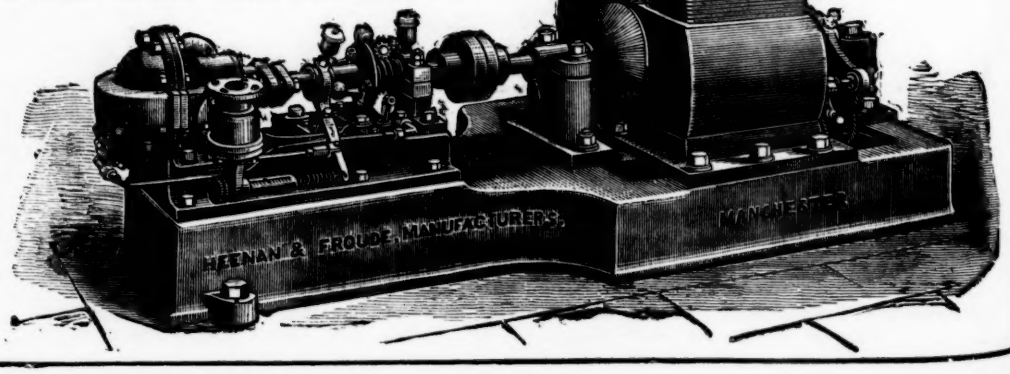
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